U.S. Army Environmental Center
Environmental Technology Division
Edgewood Area
Aberdeen Proving Ground, Maryland

Evaluation Of A Transportable Hot-Gas Decontamination System For The Decontamination Of Explosives-Contaminated Debris & Piping

OPERATIONS & MAINTENANCE MANUAL

Volume III

WESTON

FINAL 7456

COMPANY NAME: ROY F WESTON, INC/C/O: AAAP

ADDRESS: 14571 PLANT ROAD

CITY, STATE, ZIP: ALPINE, AL 35014

IMPORTANT INSTRUCTIONS
FOR FUTURE PARTS ORDERING
THE FOLLOWING INFORMATION MUST BE
GIVEN WHENEVER PLACING AN ORDER
FOR REPLACEMENT PARTS

MODEL
NUMBER: FBG5610-F928-01-G310-480R3GF-I94

SERIAL
NUMBER: I294LL

NO ORDERS WILL BE PROCESSED WITHOUT THIS INFORMATION

EACH L&L FURNACE IS UNIQUE, AND IDENTIFIED THROUGH THESE NUMBERS.

PLEASE KEEP THIS INFORMATION WHERE IT WILL BE EASILY AVAILABLE.

The model number gives us pertinent information about original drawings and electrical. Also all parts orders are filed with the orig\ al furnace file. While the serial numbers are kept separate and used as a source to double check. Also, changes made throughout the life of each furnace are kept in that furnace file. This helps L&L keep an up to date history on each furnace

OPERATING MANUAL

CONTAINS IMPORTANT CAUTIONS AND INFORMATION SPECIFIC TO THIS PARTICULAR FURNACE

REVISION P

(June 27, 1995)

MODEL NO.: FBG5610-F928-01-G310-480R3GF-I94
SERIAL NUMBER: I294LL
CUSTOMER: Roy F. Weston, Inc.

WHO SHOULD READ THESE INSTRUCTIONS: Anyone operating the furnace with the atmosphere system MUST read these instructions and be completely familiar with them. Operator training is available from the factory and engineers are available to answer questions. In addition, the person responsible for the facilities engineering in the customer's plant and/or the safety director should read these and verify that the ENTIRE INSTALLATION is safe.

DO NOT HESITATE TO CALL L&L SPECIAL FURNACE CO., INC. ABOUT ANY QUESTIONS THAT COME UP: PHONE: 610-459-9216 FAX: 610-459-3689

NOTE: All information in this manual is believed to be correct. However, L&L welcomes any feedback from the customer concerning corrections, suggestions or additions. This will be incorporated into a revised version and provided to the customer.

TABLE OF CONTENTS

CAUTIONS AND WARNINGS

TEMPERATURE LIMITATIONS

- Maximum temperature of furnace is 1200°F Set the high limit control no greater than 25°F above furnace maximum temperature.

MAXIMUM LOADING

- **MAXIMUM LOAD ON HEARTH**: 3000 Pounds evenly loaded

GENERAL CAUTIONS

- Do not override any of the important safety systems. If there is a need to do this for any reason, consult with an L&L Engineer before proceeding.
- Perform all maintenance tests on the specified schedule.
- Wear protective coverings (such as heat resistant gloves) to protect the operator from burns from the hot furnace
- When loading with the portable ramp be sure to clamp the ramp to the furnace so that it can not move while the forklift is on the ramp. Failure to do this could result in a serious injury from a forklift accident.

GAS CAUTIONS

- Follow all local and national codes when hooking up the gas and electrical supplies. Be sure to install a drip leg in the gas line hook up.
- Do not exceed the recommended gas operating pressures. Failure to do so could cause a dangerous situation. If the gas pressure is too low at the burner the resulting combustion will cause dangerous aldehydes as a product of combustion. This can be detected by an acrid smell and a burning sensation in the eyes. If the gas pressures at the burner are adjusted according to the Eclipse instructions then all will be well.
- The furnace is set up for use with propane. It can be readjusted for use with gas. If this becomes necessary consult with an L&L engineer.
- The gas burner has three ports for checking various pressures. Remove the gas cocks after you have set all gas burner pressures and plug the port with threaded inserts. This way no one can inadvertently open a gas cock and leak gas into the room.
- DO NOT TURN OFF THE POWER TO THE FURNACE UNTIL IT IS BELOW 1000°F. The combustion blower operates whenever the power is on. This will help keep the burners cool and result in longer burner life.
- When servicing the inside of the furnace: Never close the door with a man in the furnace while doing maintenance of the furnace unless strict and careful precautions are observed. All power should be disconnected. All gases should be shut off and the furnace should be completely and continuously evacuated. USE THE LOCKOUT PROVISIONS ON THE GAS VALVE AND ELECTRICAL SYSTEM. The buddy system should be used to monitor the fact that the worker inside the furnace is O.K. Emergency supply of breathing air should be on hand inside the furnace. A serious asphyxiation hazard exists.
- **NOTE: this furnace has an emergency exit door. Once it is used it must be repacked with insulation.**

GENERAL DESCRIPTION AND THEORY OF OPERATION

GENERAL DESCRIPTION AND PURPOSE OF OVEN
This is a gas fired box furnace with complete gas safeties and digital control system. It is intended for burning off certain compounds at temperatures up to 1200°F.

ELECTRICAL SYSTEM
Read the "Sequence of Operations" along with the ladder wiring diagram for a complete understanding of how the electrical system operates.

GAS SYSTEM
A complete gas train diagram is provided detailing piping schematic.

CASE CONSTRUCTION
Welded 3/16" case with strongly reinforced and integrated base. There are external bracing members welded to the entire case and base assembly. Leveling bolts and anchoring holes are included. Lifting rings are included. The main seams are continuously welded for an attractive appearance. The furnace case is designed to be transported. It can be picked up from the side by a forklift or lifted from overhead by a crane with the supplied lifting hooks.

USE OF THE FURNACE OUTSIDE: CONSIDERATIONS

The furnace is designed to be used outside. All seams are continuously welded. There are drip shields to protect the door seal from rain and the furnace mounted control panel. While in storage, however, it is recommended to put a tarp over the top of the furnace to help protect it from the elements. In particular, try to protect the door seal. The insulation around the door seal will want to absorb water. When starting up the furnace after prolonged exposure to the elements it is recommended to do a dry out cycle before using. Fire the furnace for 2 hours at 200°F and ramp to 500°F in 3 hours and hold there for 2 hours.

PAINT

High temperature primer is painted on all surfaces and finished with an enamel.

4" 2300°F 10 LB DENSITY PYROBLOCK INSULATION

The sides, back, door and top surfaces are insulated with Thermal Ceramics Pyroblock 2300°F ceramic fiber modules, 4" thick, 10 lb density. At 1200°F the cold face temperature is 164°F. At 500°F the cold face temperature is 105°F. These modules may shrink slightly with time and temperature. If cracks develop ((more than a 1/8") you will need to stuff the cracks with a 2300°F grade ceramic fiber blanket.

CASTABLE BOTTOM INSULATION

The bottom is insulated with 2-1/2" of 2200°F lightweight castable refractory backed up with 2-1/2 of 2300°F firebrick backed up with 1" of calcium silicate. At 1200°F the cold face temperature is 206°F

VESTIBULE DESIGN

There is a ceramic fiber board vestibule that surrounds the door perimeter to minimize heat loss when the door is opened.

NO ASBESTOS

No asbestos or asbestos products are used in manufacture.

HORIZONTAL DOOR WITH GASKETED DOOR SEAL

The door is a double pivoted horizontal door with thrust bearings for ease of operation. The double pivoting allows the hotface to be kept from the operator. There are six large manual turndown clamps for tight sealing. Because of the completely horizontal motion of the door as it is sealing there is no wear on the gaskets. There is a ladder on the door to assist the operator in actuating the top latches.

SAFETY MAN DOOR

There is a safety door for a man to exit in an emergency if the main door was ever closed while doing maintenance. This features spring loaded latches. DO NOT USE THIS EXCEPT IN THE CASE OF AN EMERGENCY. The fiber modules will need to be repaired after each use of this door.

CASTABLE FLAT HEARTH

Furnace includes a 2-1/2" thick flat castable hearth. This is made in segmented pieces with expansion joints. You may want to cover this with plates of steel for wear resistance. This way you would not have to repour the bottom castable to repair the furnace.

PORTABLE RAMP

A portable metal ramp is provided to enable a forklift to be driven into the furnace for loading purposes. This has eyehook clamps for attaching to the furnace while loading. BE SURE TO USE THESE SO THAT THE RAMP DOES NOT MOVE WHILE LOADING.

TEST PLATES AND PORTS

There are several test ports and special plates for testing included.

CONTROL SYSTEM

FLOOR MOUNTED REMOTE CONTROL PANEL AND FURNACE PANEL

Floor mounted NEMA 12 panel with hinged door and an Allen Bradley fused disconnect switch. Interior painted white. JIC wire coding and wire ducts. Includes door pocket for wiring diagrams. there is a separate panel (NEMA 4) at the furnace (outside the 10 foot explosion proof zone) which houses the high limit control, the flame safety module, and various other

components necessary for operating the furnace. There are special plugs supplied for the various signal wire, high voltage wires and low voltage wires.

GROUNDED COMMON TERMINAL ON CONTROL TRANSFORMER
Normally L&L grounds the common "X2" terminal of the control transformer per JIC code. All wires from this terminal are white, and are not fused.

MAIN TERMINAL STRIP
All control wires terminate in a common terminal strip in the control panel for easy trouble shooting.

WIRE MARKING
All wires are numbered at both ends with printed wire markers. All ungrounded ("hot") control wires are red, and grounded common wires are white. Grounding wires are green. All terminal strips are marked.

INTERCONNECTION WIRING AND PIPING FOR GAS FURNACES
All interconnection wiring is run inside of conduit. All interconnection wiring is run at the factory and completely tested before being disconnected for shipment. All piping includes unions for easy disassembly and reassembly of major components.

COMPONENT MARKING
All electrical components, where possible, are identified within the control cabinet and other terminal boxes with printed labels. The identification numbers correspond to the electrical diagram. This aids in troubleshooting.

LIGHTED ON/OFF SWITCH
Lighted NEMA 13 oil tight On/Off push button switch.

CONTROL VOLTAGE IS 120 VAC
Control transformer supplies 120 volts to controls.

FUSING
Full branch circuit fusing to JIC and NEC electrical codes.

DOOR SWITCH TURNS BURNER DOWN
Burner goes to low fire automatically when door is opened. Door switch is NEMA 13 oil tight.

POWER CONNECTION
Single point connection of main power to control panel.

CODES MEET NEC
All wiring meets the National Electrical Code.

PROGRAMMABLE UDC 5000 TEMPERATURE CONTROL
Honeywell UDC 5000 microprocessor based digital program control. There is one program with 10 soaks and 10 ramps. Display includes English language programming information for easy set up. This is one of the easiest digital program controls to operate. Accuracy is .05% of scale (typically ±1.0°F). All PID tuning constants, maximum temperature and scale range are programmable. Five levels of data security. Deviation bargraph. High noise immunity. Numerous dedicated keys. Two year warranty. This has been completely preconfigured at L&L except for the tuning. See the separate sheet on L&L's simple tuning method to quickly tune the furnace. A configuration sheet is included with all parameters shown in case you ever have to reconfigure the control. L&L also maintains a record of this. See the separate Honeywell manual for more information concerning this control. Note also that they have a technical support hotline for service and questions.

TUNING THE PID CONSTANTS IN THE TEMPERATURE CONTROL
P.I.D. constants (Proportional band, integral and derivative) allow the control to adjust for the particular operating characteristics of your oven and load. This oven has a fairly simple feedback loop (response time from thermocouple to power output) and will not require a great deal of effort to tune. See the enclosed sheet on tuning controls ((L&L sheet:E.3.23, How to Tune Your Digital Control) which offers some practical suggestions. Tuning becomes more critical if overshoot is an issue in which case you will want to tune the system with "critical dampening." An L&L technician can also help out with suggestions and trial tuning constants if you run into problems.

OVERTEMPERATURE SYSTEM (UDC 2000)

Honeywell UDC 2000 digital high limit control. Manual Reset. Includes back up mechanical contactors and separate thermocouple. This has a maximum set point programmed into it. Press the Set Up key until you see SP in the bottom display. Then you can change the set point with the up and down arrows. Then press the Set Up key again and you will see the process variable displayed. See the separate configuration sheet which has been filled out for your control. This control is located on the furnace mounted control panel. There is a remote reset button for this control located on the remote control panel. This is an FM approved control.

TYPE K SEALED THERMOCOUPLES

Type K Chromel/Alumel sealed in an Inconel protection tube with cast aluminum head. Separate thermocouples are supplied for the control and high limit control. CAUTION : **Make sure that the thermocouple protrudes at least 1 to 2 inches into the furnace chamber. If not then the controls will sense a lower temperature than is actually the case and an overfiring could occur in the furnace.** The thermocouples are mounted to the oven with a flange and a compression fitting that allows them to have their length adjusted. Do not tighten this compression fitting until you are satisfied with their position in the oven. There is a thermocouple jack panel for connection to the load thermocouples. Load thermocouples are to be provided by customer.

THERMOCOUPLE WIRING PRACTICE

All thermocouple lead wire is shielded from electrical noise and grounded to a common ground. Lead wires are carefully run to avoid interference from power wiring.

ROSEMONT TRANSMITTERS

Various Rosemont transmitters are included for monitoring. There are ones for gas pressure. air pressure, air flow, gas flow, control & high limit thermocouple and various load thermocouples

DR450T DIGITAL ROUND CHART RECORDER

Model DR 450T Honeywell Digital Circular Chart Recorder with two digital displays (one of actual temperature reading) and digital keyboard programming. 0.1% of span accuracy (typically better than ±1°F). The recorder prints its own charts. This allows complete configuration of charts scale and speed. You can focus on a small segment of temperature or look at the whole range and easily change back and forth without changing paper. No need for preprinted paper. 10" round chart. Microprocessor based. Chart Speeds of 8 hours, 24 hours, 7 days or "x" hours from 1 to 744. Programmable in Degrees F or C. Input filter included. See the separate Honeywell manual for more information concerning this control. Note also that they have a technical support hotline for service and questions.

COMBUSTION SYSTEM

LOCATION OF THE BURNER AND FLUE

There is one burner located at the top/middle/back of the furnace firing towards the front. The flue is at the top/right/front and includes a damper and flange for mounting to the afterburner. The burner fires over the load.

EXCESS AIR BURNER AND GAS SYSTEM FOR GOOD UNIFORMITY

The furnace is heated with one Eclipse HVTA 104 high velocity burner firing with excess air for uniformity. With this system the gas line is controlled with an electric actuator/butterfly valve combination and the air is controlled with a manual butterfly valve. The excess air causes turbulence which promotes good uniformity even when the furnace is firing under the radiant heat range (about 1200°F.)

GAS TRAIN

The gas train includes a main manual shut off valve (with lock out), pressure regulator. pre and post regulator pressure gauges and post control valve pressure gauge all with shut off valves. two electro-hydraulic gas shut off valves (for redundancy) which close quickly but open slowly to prevent a fast start up, gas pressure relief valve, a hi/low gas pressure switch, a manual main gas line shut off valve (which doesn't affect the pilot system.), and a butterfly valve controlled by an electric actuator (mounted in an explosion proof housing) which in turn is controlled by the 4-20 milliamp signal from the temperature control. gas flow monitor and gas pressure monitor. The pilot line includes a pilot regulator. pilot solenoid valve, pressure gauge and shut off valve and combination adjustable orifice/shut off valve. The combustion air line includes a centrifugal direct drive combustion air blower, filter, an air pressure switch to monitor air pressure, pressure gauge and

shut off valve, air flow monitor, air pressure monitor. and manual air balancing butterfly valves at each burner. All gas and air piping is hard heavy wall piping with appropriate unions where required for disassembly.

COMBUSTION BLOWER
An Eclpse Series SMJ Turbo Combustion Blower is included. This is a centrifugal blower made of welded steel with an aluminum impeller. It is specifically designed and sized for the combustion system on this furnace.

AUTOMATIC IGNITION WITH TRANSFORMERS
Ignition of the system is automatic using an ignition transformer and spark plug. Be sure that the ignition wires do not run parallel to the signal wires from the control or UV sensor.

FLAME SAFETY AND PURGE TIMER
There is a Honeywell RM7895C flame safety package for the burner. This uses one UV sensor to monitor the pilot flame. Should this go out, the gas supply will be shut off. Purge time is 15 minutes seconds and trial for ignition time is 15 seconds.

AIR PURGE
Before ignition the system goes through a timed purge with the combustion air. Purge time is timed for a minimum of 4 volume changes before ignition is allowed.

COMBUSTION AIR FLOW SWITCH AND HIGH/LOW GAS PRESSURE SWITCH
Included as interlocks are a combustion air flow switch and a high/low gas pressure switch. Without proper readings, gas cannot flow. NOTE: If the gas high/low pressure switch is tripped because of high gas pressure you may need to relieve pressure in the steel tubing line feeding it to reset the switch. It is easy to do this by untightening the flair fitting on the bottom of this switch. Be sure to retighten and check for tighmess with soapy water.

FLUE
The furnace flues through a special stainless steel flue with a manual shut off damper. THIS DAMPER MUST BE OPEN WHEN OPERATING THE FURNACE. An afterburner hooks up to this flue.

OPERATING PROCEDURES

INITIAL ADJUSTMENT OF THE SYSTEM

- Do the following with the door open. You may need to trip the door limit switch manually to allow the burner to go to high fire.

- CAUTION: Before doing this make sure that any castable or firebrick refractory has gone through its curing cycle. you may need to keep the door open when making these adjustments so that the furnace doesn't heat up too rapidly and cause refractory ' nage. (This had been done at the factory for all supplied refractory.)

- Do a leak test on the gas piping when you FIRST pressurize the gas system. Use soapy water or some other kind of bubble type leak testing fluid. THIS IS ABSOLUTELY CRITICAL. THERE WILL BE LEAKS WHEN YOU FIRST START UP AND THIS COULD BE VERY DANGEROUS.

SETTING THE PRESSURE AND FLOW SWITCHES:

- The valve train Main Gas Cock Valve is left fully closed.

- Turn on the fu..ace and confirm that the combustion blower is rotating in the proper direction. Have an electrician change the wiring if it is not. The blower must have a load on it (it will if hooked up to our piping system.)

- The air pressure switch should be adjusted for approximately 75% of the full pressure output of the combustion air blower. This is done by removing the little silver plate on the right side of the switch and adjusting the indicator with a screw driver. You can make this adjustment by turning off the blower and observing that the air pressure switch turns off when the blower begins to "wind down". (One way to do this is to make sure the other components in the safety lockout series (the gas pressure switch and high limit control) are activated and then watch the safety pilot light which will then indicate the air pressure switch activation. Do this while turning on and off the combustion blower.

- The air flow switch should be adjusted by measuring the air flow at the burner. You want to be sure you are getting a full purge during the time period allotted for the purge time. In this particular case you want to have 330 (total internal volume) x 4 (vlume changes) or 1320 cubic feet total purge. You have 15 minutes to do this in. Therefore you need 88 cubic feet per minute flow at the burner. Therefore set the flow switch for 88 CFM. See the component instructions for how to adjust this switch.

- Turn on the gas valve.

- The gas high/low pressure switch should be set for about 4" W.C. on the low side and about 17" W.C. on the high side. These are typical settings and may need to adjusted up or down depending on the circumstances. The principle to go by is to have the narrowest band possible that will not cause nuisance shutdowns. (NOTE: Sometimes it is necessary to release pressure at the hi/low gas pressure switch if the alarm gets stuck. This can be done easily by removing the inlet to the switch and then replacing it quickly. Be careful when doing this because you will release combustible gas.)

- Adjust main gas regulator so that the outlet gas pressure is approximately 14" W.C. You will be regulating down from your house gas pressure. It may be necessary to change springs in the main regulator to achieve proper inlet pressure to our system. See the Regulator cut sheet for the various outlet pressure ranges with various springs and orifices.

SETTING THE PILOT:

- Turn off the gas cock to allow gas to flow only to the pilots. Leave the gas shut off valve in the off position (the one after the pilot pipe.) This will prevent large amounts of gas from flowing to the burners until the pilots are properly set.
- Start the burners with the BURNERS ON Switch on the control panel.
- As soon as the pilots come on adjust the pilots by turning the adjustable orifice valve near each burner. Note that the adjustment for these valves is a screw inside the valve. The lever on the perimeter of the valve is for shut off only, not adjustment.
- The pilots should be adjusted to produce a pilot flame that comes out of the burner approximately 2 to 4 inches or, alternately. The general idea is to have the pilot as low as possible so that it doesn't affect low fire adversely but high enough so that it doesn't get blown out when the burner comes on. If the internal needle valve in the adjustable orifice valve does not give you enough adjustment (i.e., the flame is too high) you can reduce the gas flow further by turning the gas cock part way closed.

SETTING HIGH FIRE:

- Close Manual Air Butterfly Valves near the burner. This will be used for adjusting the air to the burner.
- Using a manometer check the combustion air differential pressure across burner taps between taps "A" and "C". Using the manual butterfly valves, adjust the differential pressure of the of the combustion air on the burner to be a specific pressure drop based on the tables in the burner instruction book. The exact pressure drop that you want will be dependent on gas pressure at the burner and total BTUS that you want to attain on high fire.
- Light the pilots if not already lit.
- Now you will adjust the motorized butterfly valve that controls the gas. The temperature control is put into manual mode and set at 0% output. The motorized butterfly valve is adjusted so that it is closed at 0% from the control. (The indented line on the butterfly valve shaft will then be in about a 12 O'clock position.) The temperature control is then set for 100% output. (The indented line on the butterfly valve shaft will then be in about a 3 O'clock position.) The **butterfly valve is set for anywhere from 75% to 100% open** (anything after 75% open is considered fully opened.) The manual butterfly valve is left fully opened at this point.
- Measure the gas flow at the burner by measuring differential pressure between taps on the gas orifices. Adjust the gas balancing valves at the burner to match the differential pressure drop with the desire BTU output as listed in the specific Eclipse Bulletin.
- NOTE: To ensure smooth, pulsation free operation be sure that the gas pressure at tap "B" is equal to or greater than the value shown in the capacities section of the specific data sheet for your burner.
- Note: the flame will be different when the door is open than when it is closed because there will more oxygen available to the burner. Keep this in mind when adjusting.
- Using the gas and air orifice meters and/or burner ports check for stotiometric ratio of gas to air (10:1, air:gas). The furnace will fire at stotiometric or slightly excess air (up to 10% excess air) only at high fire. Below high fire the ratio will be excess air. See the venturi orifice charts or burner instruction charts to determine flows of gas and air. Readjust if necessary.

SETTING LOW FIRE:

- The low fire will be taken care of for the most part once you have adjusted the main gas and air butterfly valves and the high fire adjustment. You may need to go back and change the adjustments on the burner so that the burner fires high enough on low fire during excess air mode so that it doesn't blow out.
- Run the furnace back to high fire to see how it performs.
- Tune the furnace per L&L's tuning instructions.

NORMAL START UP

- NOTE: There is no reason to idle the furnace when not using it except for speed of heat up if this is required. There is no restriction on heat up rate inherent in the furnace insulation or burner system.
- Turn on the main gas shut off valve if not already on.
- Turn on furnace disconnect switch on main L&L control panel if it is not already on.
- Turn on the control circuit on the main L&L panel.
- Set temperature control for final set point temperature (or set up a program if you have a program control.) Set the overtemperature control for 25 to 50 degrees C above maximum set point temperature and in no case greater than 1200°F.
- Turn on furnace.
- Turn on Combustion Blower
- **Open the furnace door while purging if practical**
- System will check for all interlocking safety devices. These include the air flow switch, air pressure switch, low gas pressure, high gas pressure, and overtemperature condition.
- You may need to hit the reset button on the high limit control.
- Turn on the BURNER START switch.
- Purge timer will start purging. The PURGE indicator light will be on. The PURGE indicator light will go out after a set period of time which is designed to insure 4 volume changes of air in the system.
- Pilot solenoid valve will open and the ignition transformer will energize.
- After 15 seconds the ignition transformer will de-energize and the pilot flame will be detected by the ultra violet flame detector. If the pilot flame is not established at that point refer to the maintenance instructions for the pilot flame.
- The FLAME ON and PILOT ON indicator lights will light.
- The main gas shut off valve will open.
- Manually turn on the Outlet Gas Cock. This opens up the main gas line. Do not do this until the pilot light is proven.

- The low fire start relay will deenergize allowing the temperature control to throttle the fuel control valve from low fire minimum position to an appropriate level as determined by the control all the way up to maximum fire.

NORMAL SHUT DOWN

- Turn BURNER START switch to OFF. The FLAME ON indicator light will turn off.
- Do not turn off furnace until the temperature is below 1000°F
- Turn off the control circuit on the main L&L panel.
- Turn off Disconnect Switch and Main Shut Off Valve for gas and Manual Gas Shut Off Valve.

EMERGENCY PROCEDURES

A LEAK IN THE GAS LINE SHOULD BE TREATED AS AN EMERGENCY. SHUT DOWN AND REPAIR IMMEDIATELY. EVACUATE AREA OF ALL NON-ESSENTIAL PERSONNEL.

SAFETY SHUTOFF INTERLOCKS AND ALARMS

This system is equipped with a Safety Shutoff System. In case of the conditions listed below, the Safety Shutoff solenoid valves for gas will close, stopping the flow of gas to the furnace. Check wiring ladder diagram for complete understanding of how alarms work.

- Low pressure of combustion air.
- Low combustion air flow
- Overtemperature condition as sensed by high limit control.
- Pilot flame goes out as sensed by UV sensor.
- Low pressure of gas.
- High pressure of gas.

PLANNED MAINTENANCE

FURNACE INSULATION: Inspect carefully every 6 months. Repair any torn fiber or patch any broken castable or firebrick. See sheet in instruction book on how to repair firebrick. Stuff any cracks with fiber.

CONTROL CALIBRATION: The controls should be calibrated or checked against some standard (such as U.S. National Bureau of Standards or other international standard) once every year.

THERMOCOUPLES: The type K thermocouples should be replaced periodically. They should be checked for accuracy every 6 months. Spares should be stocked. Type R thermocouples are fragile and should be stocked in case of breakage.

UV SENSOR: Clean with a clean soft dry cloth every 3 to 6 months. Keep a spare.

GAS TRAIN LEAK TEST: Do a leak test on gas piping once a year using 30 psi of compressed air or inert gas using soapy water to detect leaks.

NOTE CONCERNING LEAK TESTING: The use of "snoop" or other commercially available leak testing fluid is highly recommended. Use soapy water if nothing else is available. Put this fluid soapy water mixture around every fitting and pressurize the system. Obvious leaks will be detected immediately. After a few minutes, smaller leaks will be detected. A leak will show from the bubbling of the soapy water.

GENERAL GAS LINE INSTRUCTIONS: Before any maintenance is done, all gas pressure in the system should be relieved To do this, close all the main gas shut off valves and wait a while if you can't purge the line with inert gas.

GAS BURNER: See the specific instruction sheet from Eclipse. Check bolts for tightness.

WAFER BUTTERFLY VALVE: See the specific instruction sheet 720-1 from Eclipse. Lubricate once a year. There is a grease fitting supplied at the shaft end of the valve body. A pipe plug at the opposite end of the shaft can be removed and the opening packed with grease.

ELECTRIC ACTUATOR FOR COMBUSTION AIR CONTROL: See the specific instruction sheet from Honeywell. There are various adjustments on this actuator. Oil the linkages on this and all other mechanical linkages in the system.

LOW & HIGH PRESSURE SWITCHES: Check the actual setpoint of the Pressure Switches every year.

COMBUSTION BLOWER: See the specific instruction sheet from Eclipse. Inspect and clean rotors as required. Be careful of imbalancing caused by excessive dirt that may be distributed unevenly on the rotor. If the rotor fails be sure to check the motor bearings for excessive wear. Worn bearings are often the cause of rotor failure. **Change or clean filter as necessary.**

LUBRICATED GAS COCKS: These must be relubricated after 200 to 400 cycles. See Eclipse bulletin 712.

SYSTEM SETTINGS AND REQUIRED UTILITIES

VOLTS:: 480/3/60
PROPANE: 5 psi connected pressure.
BTU: 1,000,000

MAXIMUM TEMPERATURE: 1200.
MAXIMUM LOAD WEIGHT ON HEARTH: 3000 pounds

GLOSSARY

The following is a glossary of terms commonly used in reference to L&L Special Furnace Co.,Inc., heat treating furnaces, options, components, materials and control systems.

FURNACES, OVENS, KILNS

The terms "furnaces", "ovens" and "kilns" are often used interchangeably. Ovens are heating chambers normally with a maximum temperature of 1200°F or less. Furnaces normally have a higher temperature limit than this. Kilns are normally used for ceramic work. However, there is no necessa y technical difference between any of these three terms. The only normal technical difference is that ovens usually have some sort of air recirculating system for uniformity improvement at the lower temperatures and/or are metal lined instead of refractory lined.

ATMOSPHERES

General: The gas inside the furnace chamber, whether air or special protective gas.

Inert: A gas or gas mixture which, strictly speaking, has no effect on the furnace interior or the load. Normally, what is meant is a gas or gas mixture which has less than 4% flammable gas. Such gasses as nitrogen, argon, and helium are normally considered inert. However, some steels can be affected by nitrogen, and some steels can be decarburized (lose hardness) in pure nitrogen or argon. A metallurgist should be consulted to recommend specific procedures. (Alternately you can contact one of the industrial gas suppliers such as Airco or Linde for technical information.)

Combustible: Any gas or gas mixture which contains more than 4% flammable gas. Most exothermic and all endothermic process gas mixtures are considered combustible. Hyrodrogen is the most combustible of gasses. Other combustible gasses include carbon monoxide.

Oxidizing: A gas or gas mixture in which oxidation, or burning, can be supported. Air is an oxidizing gas mixture, as are oxygen and chlorine.

Reducing: A gas or gas mixture in which oxides are removed, or 'reduced.' Hydrogen is an excellent reducing gas. Most reducing gas mixtures burn in air, and are therefore 'combustible.'

Exothermic: Produced from natural gas by burning in air. Components include 0.1%-CO_2 (carbon dioxide), 19.8%-CO (carbon monoxide), 40.4%-H_2 (hydrogen), 0.5%-unburned CH_4 (methane), 39.0%-N (nitrogen) and 0.2%-H_2O (water vapor).

Endothermic: Produced from natural gas by heating in the absence of air. Percent of gas varies with adjustment of the system. Components of the gas are same as exothermic gas. A "Lean" endothermic gas has 1-4% combustibles and is considered inert while a rich endothermic gas has 10-21% combustibles and is considered flammable

Dissociated Ammonia: Formed by separating the component parts of ammonia in an ammonia dissociator. Components include 75% H_2 and 25% N.

Forming Gas: This is a prepared gas mixed by an industrial gas supplier or mixed on site with a gas mixing device. Includes from 4% to 5% H_2 with the remainder being nitrogen or argon.

NFPA 86C: This refers to the National Fire Protection Agency booklet on Flammable atmospheres. You can obtain a copy of this industrial standard by writing to the National Fire Protection Agency, Batterymarch Park, Quincy, MA 02269 and asking for their booklet NFPA 86C. There is a nominal charge.

Retort or Muffle: A retort or muffle is an enclosed container for holding a protective atmosphere inside a furnace. It can be made of quartz, alumina, or ceramic but is most commonly made of one of the high temperature alloys. "Retort" generally refers to a round container while muffle generally refers to a rectangular container. NOTE: the term "muffle furnace", which is an older term, often refers to a simple box furnace with no internal container as mentioned above.

ELECTRICAL TERMINOLOGY

K.W.: K.W. standands for kilowatts. 1000 watts equals one kilowatt. or 1 K.W. Watts is a measure of power required by the furnace.

Volts: Volts is the "pressure" of the electrical energy available. The higher the voltage the more pressure or force with which the power is forced through the wires. Higher voltage requires smaller wires but greater electrical insulation. (For instance, larger fuse blocks to prevent potential short circuits.)

GLOSSARY FOR L&L SPECIAL FURNACE CO., INC.

Ohms: Ohms is a measure of resistance. The higher the resistance the more power is required to force the electrical energy through the element wires.

Amperage: Amperage is the volume of electrical energy going through an electrical system. The higher the amounts (at a constant voltage), the more K.W. or power is being used.

Ohm's Law: Ohms's law is a statement of the mathematical relationship between watts, ohms, amperago and volts. Several of the more common formulas are:

Volts = Amperes X Ohms
Volts = Wattage / Amperes
Amperes = Square Root of Watts / Ohms
Amperes = Volts / Ohms
Watts = Volts X Amperes
Watts = (Amperes)2 X Ohms

CONTROLS

Temperature Controller: The device which controls the furnace temperature, whether by electronic or mechanical means. L&L Special Furnace Co.,Inc., normally uses a solid state, electronic type of temperature control which controls the heating elements by switching a set of power contactors on and off.

P.I.D. or Three Mode: A type of time proportioning control which uses three factors to vary control output. This is the most precise method of temperature control. L&L Special Furnace Co.,Inc., uses P.I.D. controllers exclusively in all furnace models except the HB models (where P.I.D. controllers are optional.) The three factors are: P: Proportional= Proportional band or gain. : Integral = Reset. D: Derivative = Rate.

P.I.D. control action anticipates the set point as the furnace temperature increases. Control output is 100% until furnace temperature reaches a 'proportional band,' which is a range of temperature below the set point in which control output is gradually decreased as the set point is approached. The reset and rate factors are used to fine tune the controller to the furnace. See the information provided for the control for a deeper explanation of this.

Time Proportioning: A type of control action which proportions output by means of a control relay. The relay is cycled on and off, with the on time in direct proportion to the amount of output called for. L&L Special Furnace Co.,Inc., uses time proportioning type controls as a standard; these are used to switch power contactors on and off to control furnace temperature.

Current Proportioning: A type of control action which proportions output by means of a DC milliamperage. Normal milliampere range is 4 to 20 mA. This is used as an input signal to the firing circuit of an SCR power control. This is a more precise method of power control than power contactors, because actual power input to the furnace elements is proportioned by the temperature controller. Elements are never just on or off. See the section in this GLOSSARY for more information of SCRs.

OVERTEMPERATURE CONTROL OR HIGH LIMIT CONTROLS

Overtemperature control or high limit control: The purpose of this is to act as a safety in case the main temperature control fails or becomes inaccurate and the furnace overfires. The overtemperature control then takes over and shuts the furnace off. Normally this control is used in conjunction with back up safety contactors.

Back up safety contactors: These are separate mechanical contactors that are operated by the overtemperature control. In case the main contactors were to fail and freeze in the closed position these contactors would still be able to break and stop the furnace from overfiring.

TEMPERATURE RECORDERS

Temperature Recorder: This is a device that records the temperature in the furnace on chart paper.

Strip Chart: Strip Chart Recorders feed a long continuous "strip" of paper through the recorder at a constant speed while the pen of the recorder moves across the width of this paper recording the temperature that corresponds to a specific scale printed on the paper.

Round Chart: A round chart recorder has a circular piece of paper which turns on the round chart recorder while the pen of the recorder moves across the radius of the chart.

Single Pen: A single pen recorder has one pen and one temperature input.

Multi-Pen: A multi-pen recorder has two or more pens that record on the same chart in the same time frame.

Multi-Point: A multi-point recorder is similar to a multi-pen recorder. The main difference is that many "points", or temperature signals, (up to 12 on some instruments) are recorded with the same pen. Some multi-point recorders also have 2 or more pens to record 24 or more points.

GLOSSARY FOR L&L SPECIAL FURNACE CO., INC.

ELEMENTS

Nickel-Chrome: Normally the element alloy of this designation is 20% chrome and 80% nickel. One commonly used trade name of this type of element is Nichrome.

Iron-Chrome-Aluminum: Also known and commonly referred to by the trade name "Kanthal". Iron-aluminum-chrome alloy gets its high temperature resistance from the fact that the aluminum in the alloy oxidizes and creates a tough coating on the outside of the element.

Wire Wound: Refers to elements that are made from wire as opposed to strip or rod. The elements are wound into coils.

Silicon Carbide: Silicon Carbide elements are high temperature elements made from silicon carbide. Normally they will reach 2800°F (but can go higher in temperature). They require low voltage normally and, because they change in resistance over time, they normally require a tap transformer system which allows the voltage to be changed to the elements.

Watt Density: Watt density is a measure of the number of watts per square inch of radiating element surface area. The greater the density the shorter the element life and vice versa. A watt density below 15 watts per square inch is considered acceptable (according to standard commercial practice and by military specification MIL-F-80079B.) L&L tries to design most of its elements to under 10 watts per square inch which is far better than normal standards.

INSULATORS

Element Holders: See GENERAL PARTS LIST for information of the type of element holders used in your specific furnace. All L&L element holders are made from a specially developed high temperature ceramic body.

Ceramic Terminal Blocks: These are the press molded ceramic blocks that the element ends get attached to. Also the power connections to the elements gets made here. See GENERAL PARTS LIST.

Insulator Tubes: These are the thin walled ceramic tubes with a single hole in the middle. They are about 9" long. The ends of the elements go through these tubes as they protrude through the furnace insulation. They prevent short circuits in the element ends.

Ebony Terminal Boards: Some furnaces (the HB and some other furnaces) use these instead of the ceramic terminal blocks. These boards are a high temperature non-asbestos electrically insulating material.

CONTACTORS

NOTE: Some people refer to contactors as relays or switches. Contactors are the devices usually used in L&L furnaces to do the main power switching. Normally a smaller contactor or relay in the temperature control sends a signal to the contactor whether to open or close and this allows power to flow through to the elements.

Electro-mechanical: These contactors have a coil and a spring which when energized pull two sets of open contacts together. When the contacts mate power flows between them and the contactor is considered in the closed position. The problem with mechanical contactors is that there is often an electrical arcing that takes place when the contacts open and close. This arcing causes a high temperature which oxidizes the contacts and can damage the plastic body of the contactor over time. Also the continual switching of the contactor can cause eventual mechanical fatigue in the spring and body of the contactor.

Mercury: Mercury contactors, which are used on most L&L furnaces for the main power contactors, have an enclosed pool of mercury which moves back and forth to make the electrical contact. They are quiet and fast and there is no mechanical fatigue associated with these contactors.

Solid State: Solid state contactors use an electronic switching device to switch power on or off. There is no mechanical movement whatsoever. They have the advantage of producing no noticeable electronic interference or line noise which can be useful around some delicate program controls or computors.

THERMOCOUPLES

NOTE: Some people refer to these as Elements, Sensors and Probes. All thermocouples work on the theory that dissimilar metals, when welded or fused together, create a variable millivoltage which is essentially proportional to temperature. Different thermocouples have different temperature ranges. In addition, some of the higher range thermocouples are not accurate in the lower temperature ranges.

Chromel/Alumel: Type K. Good to 2500°F but not particularly accurate above 2200°F. This is the thermocouple that is used on most L&L furnaces that go up to 2350°F. (Note: Type R thermocouples are offered as options on these furnaces.)

Platinum: Type R, Type S, Type B. Type R and Type S are are useful up to 3000°F. Type B is used for higher temperatures. All use precious metals and are expensive. They are not very accurate below about 1700°F. Type R thermocouples have one wire which is 100% platinum and one wire which is 13% Rhodium and the rest platinum. Type S thermocouple have one wire which is 100% platimum and one wire which is 10% rhodium, 90% platinum.

Protection Tubes: Some thermcouples have an open junction (the junction is where the two wires of the thermocouple are joined) and some have "Protection tubes" which cover the junction and the ceramic insulating tube that holds the length of the thermocouple. The protection tube protects the junction from deterioration from mechanical and chemical abuse. It has the disadvantage of making the thermocouple less responsive to rapid changes in temperature. There are three types of protection tubes generally used in thermocouples on L&L furnaces. One type is inconel sheathed, one is mullite sheathed and one is alumina sheathed (in order of temperature limitations.) Many come with with a cast aluminum thermocouple head (where the hook up terminals are.)

Flexible: Flexible thermocouples are made so that the body of the thermocouple will be flexible and allow the end of the thermocouple to be positioned anywhere within the furnace. There are two types used. One has an alloy sheath on the outside that looks similar to romex cable. The other type has a thin wall smooth alloy covering. These are not as flexible as the other type but have the advantage of having a cast aluminum terminal head which allows them to be used with atmosphere sealed cases. The major use of flexible thermocouples is to allow the thermocouple to be placed directly on a part in order to be very accurate.

BACK-UP INSULATION

NOTE: L&L uses various kinds of back up insulation in its furnaces.

Mineral Fiber Block: This is the standard type of mineral wool insulation L&L uses on the sides, top, and back of the furnaces. It is a light tan in appearance.

Calcium Silicate: This is generally used in the bottoms and the doors because it is virtually noncompressable. It is white and powdery in appearance.

Monoblock: This material is occasionally used as back up material. It is not very compressable and is a dark brown in appearance.

INSULATING FIREBRICK

NOTE: Firebrick is also known as Brick, IFB and Insulating Firebrick. There are many grades and types of firebrick with a wide variety of insulating, mechanical and temperature limitation properties. L&L normally uses two different types of firebrick. One is standard medium temperature firebrick and the other is a 2800°F IFB. On some furnaces 2500°F IFB is used. Most firebrick is a mixture of alumina and silica in various percentages. The more alumina, the higher the temperature limit.

Standard: The standard medium temperature firebrick is highly insulating. It is also relatively soft.

Seal firebrick and high temperature firebrick: This brick is 2800°F firebrick. It is very hard. However, it does not insulate as well as the medium temperature firebrick and so must be backed up with other firebrick or high temperature mineral wool for better insulation value.

Castable: Castable refractory is heavier than firebrick and is much stronger. It is cast in place like cement. L&L normally reinforces castable insulation with stainless steel fibers which help hold it together better.

CERAMIC FIBER

NOTE: Ceramic fiber is made in several temperature ranges and with several densities. It can be made into a number of different products including blanket, vacuum cast parts, modules, cast fiber board, paper, woven fiber gaskets as well as other products. Generally speaking ceramic fiber will resist at least 1800°F and can go as high in temperature as 3000°F. It is made by blowing molten ceramic into a fibrous material. In many ceramic fiber products there is a small amount of organic binder. This aids in the fabrication of the product into its final form. Upon first firing this binder burns out and causes smoke. (Be sure to ventilate this smoke.) This is a one time problem. See the Product Safety Information in your Instruction Book concerning safety aspects of ceramic fiber. Unlike asbestos fibers, ceramic fibers break across the width of the fiber. Asbestos fibers fracture along the length of the fiber. The reason that asbestos fibers are so dangerous is because they keep getting finer and finer and so are able to

penetrate the delicate tissues of the inner lungs. This does not happen with ceramic fiber. Ceramic fiber tends to shrink when heated beyond certain temperatures. All L&L designs that utilize ceramic fiber take this shrinkage problem into account.

Fiber Blanket: The ceramic fiber is made into a blanket similar to fiberglass insulating blanket. The fibers are generally oriented along the length of the blanket rather than across the thickness. This is important because most shrinkage of ceramic fiber takes place along the length of the fibers. This means that the blanket loses length but not thickness when it is heated to shrinkage temperatures. Most blanket is 1" thick. The most common blanket has a density of 6 pounds per cubic foot.

Fiber Modules: There are several different kinds of modules on the market. L&L makes its own modules which allow us to combine ceramic fiber with lower temperature and better insulating back up insulation as well as allow us to use our own unique element system on certain furnaces. L&L modules have ceramic fiber blanket "stacked" on edge and held in place mechanically by stainless steel rods. They are 12" by 12" or smaller. L&L modules are attached to the case with metal screws.

Fiber Board: Fiber board is made by vacuum casting a mixture of loose ceramic fibers with various mixtures of clay and colloidal silica or colloidal alumina. The silica and/or alumina hold the fiber together in a hard board-like material. The advantage of ceramic fiber board over other refractory materials is that it is hard yet not particularly fragile. It does not easily chip or fracture the way that firebrick does. Also it is a more efficient insulator than standard firebrick. Normally the density of the ceramic fiber board is about 16 pounds per square foot. It comes in thicknesses of 1/2", 1", 2" and a few other odd sizes. L&L uses 2300°F, 2600°F, and 3000°F. board material.

Moldable 3000 Fiber: This material is a moldable ceramic fiber material that will withstand 3000°F. You can purchase it from L&L from your PARTS LIST. It can be used for all sorts of repairs. It comes in a wet dough like mixture and dries hard.

HIGH TEMPERATURE ALLOYS

NOTE: A wide variety of high temperature alloys are used in furnaces. Some of the more common ones are mentioned below.

304 Stainless Steel: The most commonly used stainless steel. Useful in most furnace applications up to 1400of.

330 Alloy: Normally used up to 2000°F. Can be used higher.

Inconel 600 Series alloys: Can be used up to 2200°F and in some cases even higher.

SCR POWER CONTROLS

SCR power controls are used to accurately control power to the furnace heating elements. A DC milliampere signal is generated by the current proportioning temperature controller, and fed to the firing circuit of the SCR. The firing circuit then switches the SCR in proportion to the milliampere signal. SCR's replace power contactors as the main power switching device to the elements. There are several different types of SCR's to be used for different heating applications.

Zero Fired: (Also called Synchronous Firing.) This is the type used by L&L Special Furnace Co.,Inc., for most applications. The firing circuit of this type switches the power on and off only at the zero crossing of the voltage cycle, hence the term "zero fired." The number of cycles on and off is determined by the control signal. This is a good choice for most applications where the element resistance changes only very slightly as the elements increase in temperature and as they age. Advantage of zero fired SCR's is that very little radio frequency interference is generated. Disadvantage is that they can not be used in applications where the load will not tolerate on/off cycling of full power.

Phase Angle Fired: This type of SCR allows the SCR to be switched on and off over portions of the voltage sine wave. The portion of the cycle on is determined by the control signal. The great advantage of this type of firing is that the amperes (current) allowed to be passed through to the elements can be limited with a special adjustment on the SCR firing circuit (current limit).

This feature allows elements with large changes in resistance in response to temperature to be controlled by phase angle SCR's. Silicon carbide elements are one example, and are used in some furnaces manufactured by L&L Special Furnace Co.,Inc. In order to reduce voltage to the level required by silicon carbide elements, the SCR usually has to be coupled with a transformer as well. The current limit feature must be used not only because of the elements, but also because of the large inrush of current into the transformer as power is switched on.

Disadvantage of the phase angle fired SCR's is that they do generate radio frequency interference, and must be specially constructed and shielded to prevent problems with other sensitive equipment. In certain cases the external environment must be modified to limit the effects of this RFI.

INSTRUCTION MANUAL INDEX

L&L SPECIAL FURNACE CO., INC.

20 Kent Road • P.O. Box 2129 • Aston, PA 19014-0129 • Phone: (610) 459-9216 • Fax: (610) 459-3689

INDEX/FURNACE DESCRIPTION
COMPANY: ROY F. WESTON, INC. SERIAL NUMBER: I29ELL
MODEL NUMBER: FBG5610-F928-01-G310-480R3GF-I94

<u>SPECIFIC INSTRUCTIONS FOR THIS MODEL:</u> THESE ARE INSERTED BEFORE ALL OTHER INSTRUCTION PARAGRAPHS

IMPORTANT CAUTIONS

PRE-OPERATION INSTALLATION

OPTIONS INSTALLATION

FURNACE OPERATION

OPTIONS OPERATION

MAINTENANCE/TROUBLESHOOTING

G.1.1	Routine Maintenance
G.2.1	Control Maintenance (General)
G.2.2	Mercury Contactors Maintenance, General
G.4.1	How to Repair Firebrick
G.5.5	Fiber Wall Maintenance
G.6.1	Troubleshooting Guide
Q12C	Warranty

PARTS LIST/ORDERING

General Parts List

WIRING DIAGRAMS

	Electrical Test Report (Includes nameplate data)
I.1.1	Test Recorder Chart

GENERAL DRAWINGS:

F928-01	REV A	WIRING DIAGRAM
F928-02	REV A	GENERAL DIMENSIONS AND ASSEMBLY
F928-03	REV A	COMBUSTION GAS SCHEMATIC
	REV A	PARTS LIST

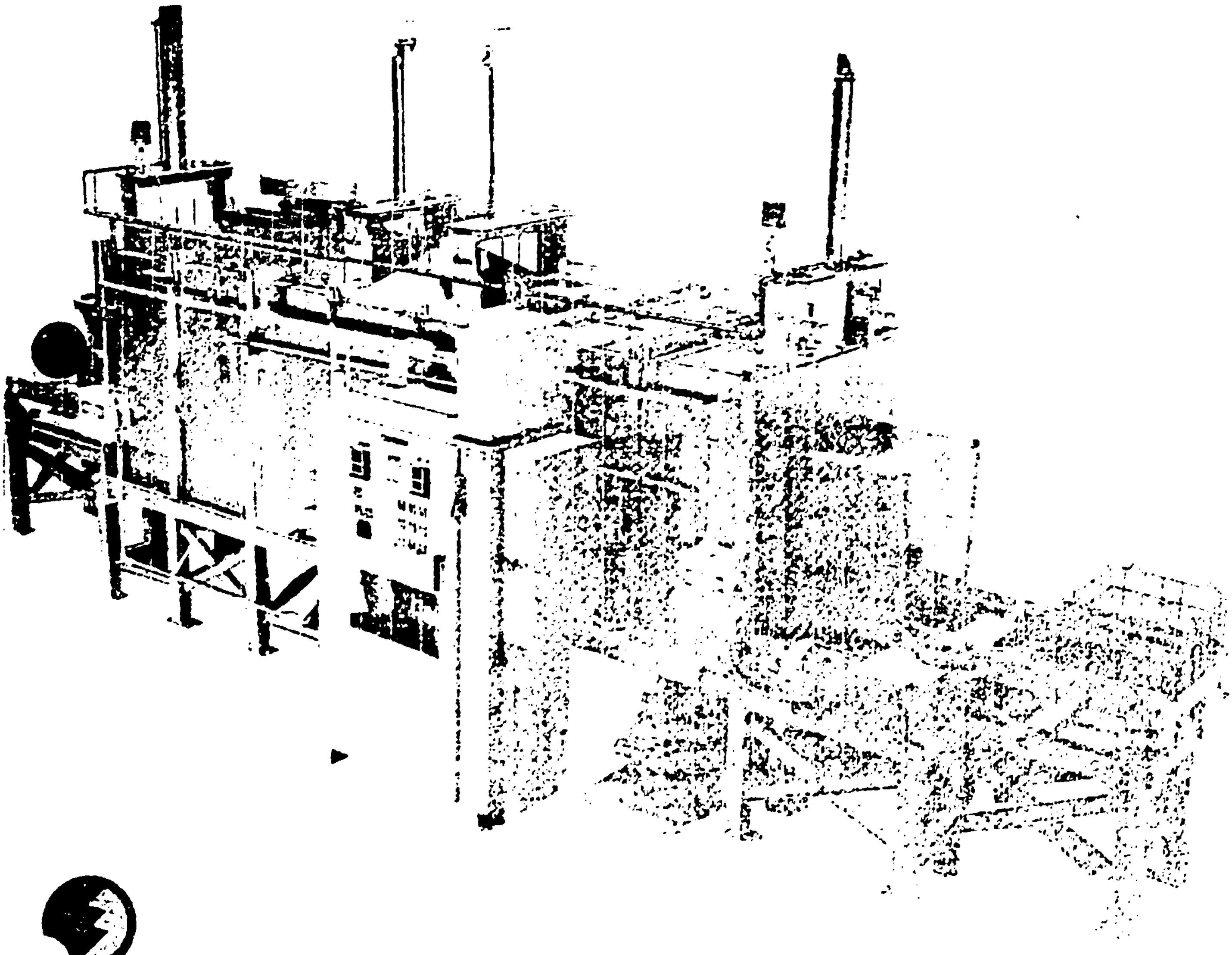
COMPONENT INSTRUCTIONS

Any auxiliary information from component manufacturers is located in this section in no particular order.

M267	HONEYWELL UDC5000 DIGITAL CONTROLLER
M577	ECLIPSE TURBO BLOWERS SERIES "SMJ"
M578	ECLIPSE INFORMATION GUIDE "SMJ" SERIES BLOWERS
M579	ECLIPSE-DUNGS HYDRAULI-MATIC GAS SHUT-OFF VALVES
M588	ECLIPSE BUTTERFLY VALVES
M621	ECLIPSE INFORMATION GUIDE ADJUSTMENT FOR BUTTERFLY VALVES
M643	HONEYWELL UDC3000/5000/6000 DIGITAL CONTROLLERS

M660	HONEYWELL DR4500A TRULINE CIRCULAR CHART RECORDER
M661	EQUIMETER 043 SERVICE REGULATOR
M684	ECLIPSE PRESSURE GAUGES
M728	APPLETON INSTRUCTION SHEET 500395-1
M732	ROSEMOUNT MODEL 1195 INTEGRAL ORIFICE
M733	ROSEMOUNT MODEL 3044C TEMPERATURE TRANSMITTERS
M734	ROSEMOUNT MODEL 3051C SMART PRESSURE TRANSMITTER FAMILY
M737	AIR FILTERS FOR ECLIPSE BLOWERS
M741	HONEYWELL UDC3000 OVERTEMPERATURE CONTROL
M752	EQUIMETER 143-80 SERVICE REGULATOR
M753	HONEYWELL Q624A SOLID STATE SPARK GENERATOR
M754	HONEYWELL EXPLOSION-PROOF HOUSING ES-650 DHE-94
M755	HONEYWELL MINIPEEPER ULTRAVIOLET FLAME DETECTORS
M756	HONEYWELL 7800 SERIES RELAY MODULE
M757	HONEYWELL MODUTROL IV MOTORS
M758	HONEYWELL AMPLIFIERS FOR THE 7800 SERIES
M759	HONEYWELL UNIVERSAL WIRING SUBBASE
M760	HONEYWELL ST7800A PLUG-IN PURGE TIMER

L&L SPECIAL FURNACE CO., INC.



INDUSTRIAL
OVENS AND
FURNACES

XL/TF SERIES

2350°F Floor Standing Medium Production Box Furnaces

The XL/TF Series floor standing box furnace features two zone control, elements on sides, back, door and bottom for even heating. 4-1/2" of firebrick with 2" of backup insulation (ceramic fiber roofs on larger ones) and a wide range of custom options.

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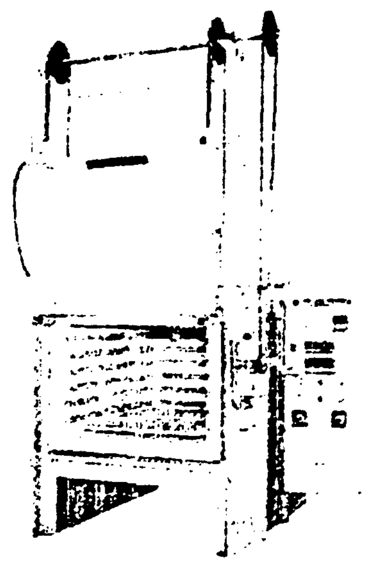

XT SERIES

2350°F Top Loading Furnace

The XT Series is similar to the XLTF Series except that it loads from the top.

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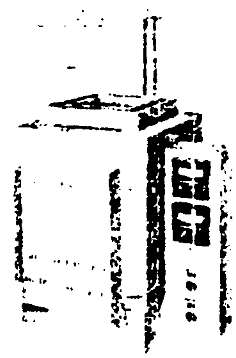

B86 SERIES

2000°F Economical Bench Top Box Furnace

The B86 is a simple economical box furnace. There is one size: 8" wide by 6" high by 16" deep with 4.0 K.W. It includes a digital 3 mode PID control and horizontal door. Maximum load is 75 pounds.

HB SERIES

2200°F Basic Bench Top Box Furnaces

The HB Series bench top box furnace features a spring loaded vertical door, wide range of options, and economical price range.

MODEL	W	H	D	K.W.	MAX LOAD
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XLB SERIES

2350°F Bench Top Precision Box Furnaces

The XLB Series features two zone operation, elements on sides, top and bottom, more accurate control system than the HB Series and larger chamber size, all factors in greater uniformity and precision control.

MODEL	W	H	D	K.W.	MAX LOAD
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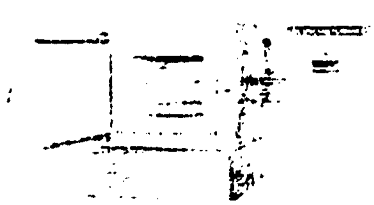

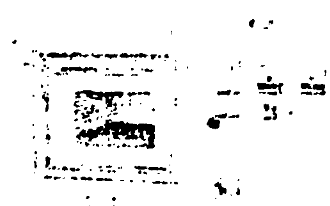

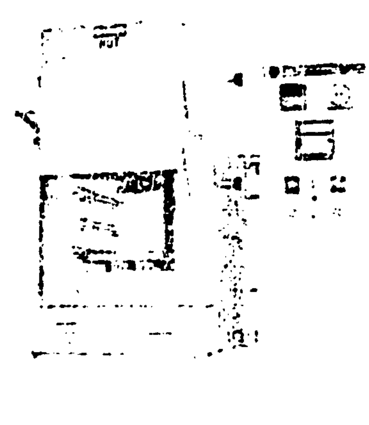

DV SERIES

1300°F Floor Standing Batch Tempering/Annealing Ovens

The DV Series Tempering Ovens feature powerful fan and recirculation baffles for high uniformity of ±10°F or better, Incoloy elements, all stainless steel interior, and heavy duty case and floor standing base construction. Air circulation is from bottom to top. The standard door is a double pivoted horizontal door which keeps the hot face from the operator. The vertical door option is shown. 1400°F operation is optional. Special hearths are optional. Special venting for solvent use is available.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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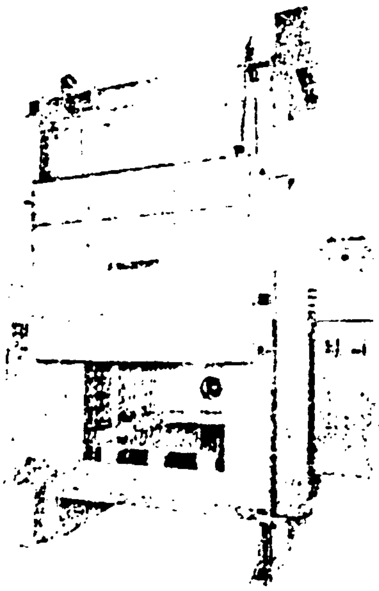
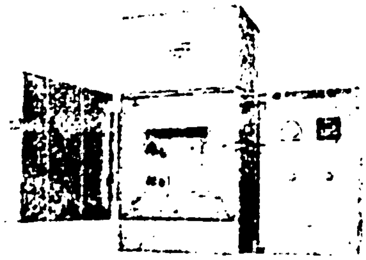


VB SERIES

1300°F Bench Top Ovens

The VB Series is similar to the DV floor standing ovens except that they are lighter duty and are bench mounted. Stainless steel lined with fan recirculation for ±10°F uniformity. Top mounted fan. Horizontal doors only.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



QD SERIES

Dual Chamber Hardening/Tempering Furnaces

The QD Series features a 2350°F furnace chamber combined in one over-under case with a 1250°F tempering oven. A version of the QD features a 1875°F tempering oven. Both chambers are firebrick lined while the tempering oven includes a stainless steel recirculation muffle and fan for chamber uniformity of ±10°F. Atmosphere, vertical doors, and other options are available. Another version has a 2500°F hardening furnace with silicon carbide elements and an 1875°F preheat/tempering furnace.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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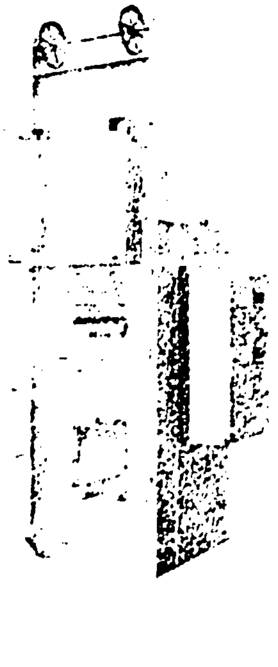

QT SERIES

Production Quench Tanks

The QT Series quench tanks feature heavy duty construction, double welded seams, vigorous agitation for uniform quenching and controlled heating for proper quench temperature. External cooling is an option. Lid is optional.

MODEL	W	H	D	K.W.	GALLONS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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FN SERIES

Ceramic Fiber Atmosphere Box Furnaces with Certifiable Uniformity of ±5°F from 300°F to 2200°F.

The FN Series features extremely tight interlocked door seals, multi-zone elements, high ratio of actual inside space to working dimensions, and fans to achieve a **guaranteed** ±5°F from 300°F to the maximum temperature of the furnace. Three temperature ranges are offered: 1800°F, 2000°F and 2200°F. Vertical electric doors with four powerful pneumatic clamps are standard. These are ideal for aircraft and other precision job shop work. Optional hydraulic lift loader is shown.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	80	[illegible]
[illegible]	24	24	[illegible]	125	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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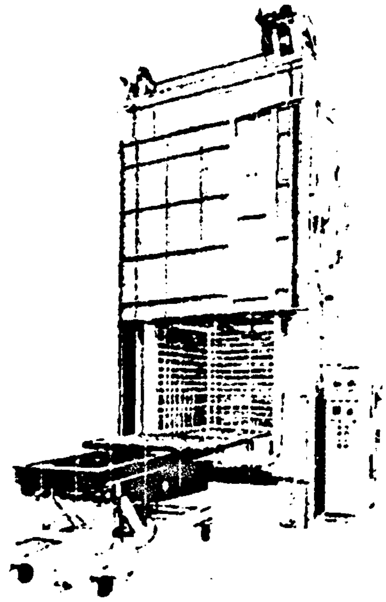
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Actual [illegible] are 12 [illegible] and 24 greater [illegible]



PT SERIES

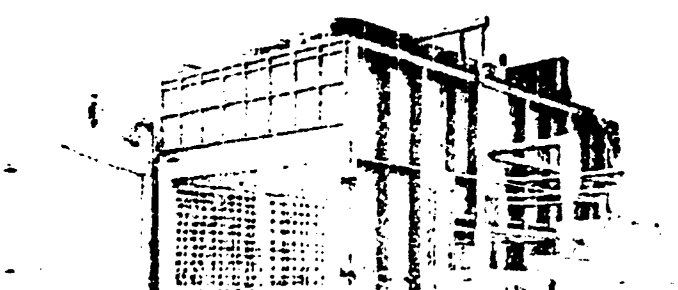
Top Loading Pit Furnaces (1000°F to 2200°F)

The PT Series are round furnaces typically installed in pits for processing of long parts that must be kept vertical. They typically have powerful bottom mounted fans and recirculation baffles for high uniformity. They may be designed for annealing, neutral hardening, carburizing, carbonitriding or a variety of other applications. Electric or gas radiant tube fired. Sizes, temperature range and design are customized for the application.

FC SERIES

Ceramic Fiber Lined Car Bottom Furnaces (Up to 2200°F)

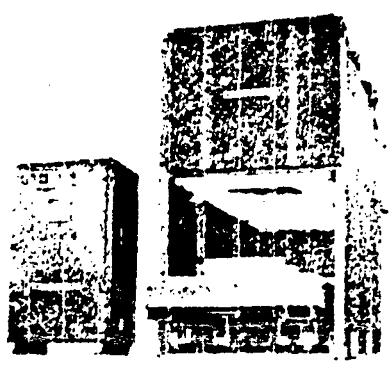
The FC Series car bottom furnaces feature ceramic fiber insulation, electric car drives, very tight and maintenance free pneumatic car seals, electric or gas fired operation, and large size and load capacity. There are standard sizes from 4' x 4' x 4' to 8' x 8' x 24' long as well as custom sizes. Options include vertical doors, fans, multi-zoning and forced cooling venturis. Shuttle types, where the furnace moves over a fixed base, are also made.



FBG SERIES

Ceramic Fiber Elevator Furnaces (2000°F to 3100°F)

The FBG Series elevator furnaces have a loading platform that rises into a box which has elements on all four sides. The platform may also be a car. Alloy, silicon carbide or molybdenum dissilicide elements are used depending on the temperature range. Multi-zoning is available. Each one is custom designed for the application.



GLF SERIES

2500°F Silicon Carbide Element Production Box Furnaces

The GLF Series features silicon carbide elements for long element life even when used in the 2000°F to 2500°F range for long cycles. Elements are mounted above and below the hearth. Door opening includes a vestibule. Firebrick and/or ceramic fiber insulation. The standard door is a double pivoted horizontal door. Many options including inert or combustible atmospheres, SCR power controls, tap transformers, and vertical doors are available. Shown is a furnace with electric operated vertical door and inert atmosphere case construction.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	18	24	[illegible]	[illegible]
[illegible]	[illegible]	18	[illegible]	47	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	64	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	42	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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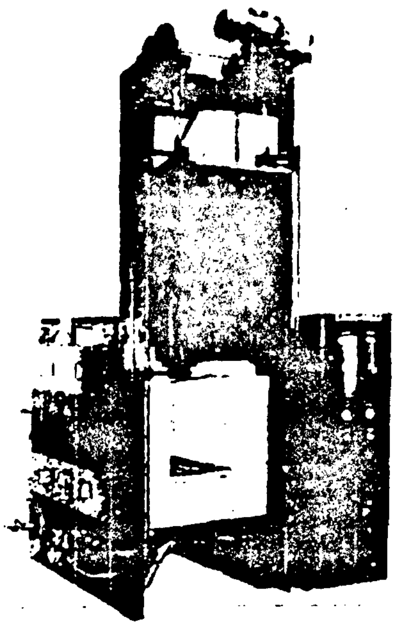

GL SERIES

2500°F Bench Top Furnaces

The GL Series is similar to the GLF Series except they are bench mounted, smaller and have less options.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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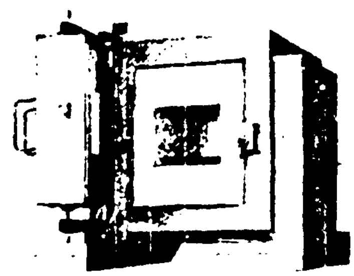

GHH SERIES

3100°F Ceramic Fiber Lined Front Loading Box Furnaces

The GHH Series features a unique Zircar Sali ceramic fiber insulation system with multiple hangers and segmented insulation sections that lasts much longer in this difficult temperature range than competing models. Insulation module is guaranteed for one full year for continuous use temperature at 1700°C. Door features triple heat lock with a deep plug. Insulation is all lightweight for super fast heat up and cool down. Includes phase angle fired SCR power control with matched transformer and Kanthal Super 33 elements. Controlled atmospheres optional.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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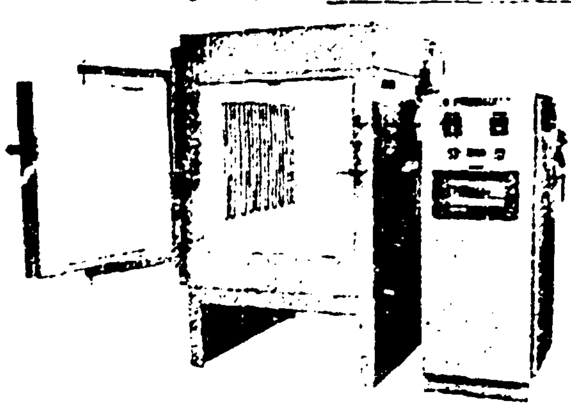

GF SERIES

2800°F Large Box Furnaces

The GF Series feature silicon carbide elements mounted top and bottom, 3000°F firebrick with back up insulation, phase angle fired SCR power control with tap transformer for mostly automatic voltage changes.

MODEL	W	H	D	K.W.	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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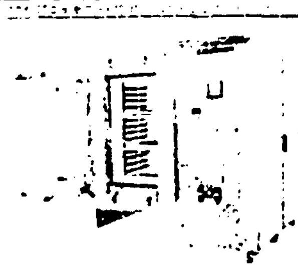
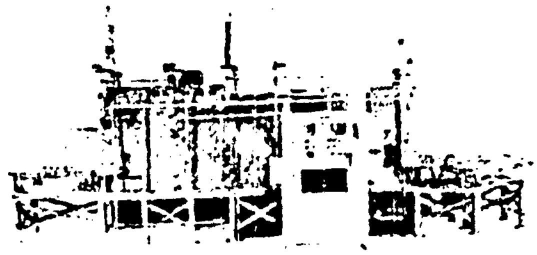


CP SERIES

Continuous Batch Production Temper Ovens (Up to 1400°F) for "Just in Time" Production

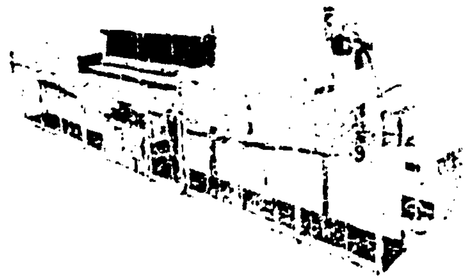
The CP Series continuous batch production ovens feature automatic batch loading, single or multiple zones, optional air and/or water cooling. Each station's load is independent and does not require another tray to move it. The CP ovens are typically used for tempering in post induction hardening operations. Gas or electric.



CV SERIES

Continuous Belt Ovens (Up to 1400°F)

The CV Series are stainless steel lined ovens with wire mesh belts. DC motor belt drive with SCR speed control. Single or multiple zones. Sizes available are up to 60" wide belts with lengths up to 80 feet long. Typically they include air recirculation. Gas or electric.



CF SERIES

Continous Belt High Temperature Furnaces (Up to 2000°F)

The CF Series feature wire mesh high alloy belts. DC motor belt drive with SCR speed control. Single or multiple temperature zones. Belt widths up to 24" wide by 30 feet long. Electric only. Elements are either alloy or silicon carbide depending on the application and temperature range. Air or controlled atmosphere with or without muffles.

PF SERIES

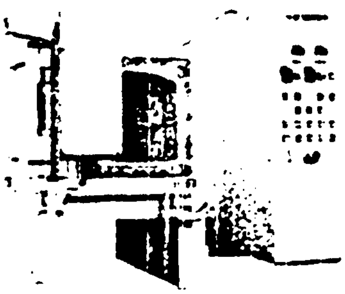
High Temperature Continuous Pusher Furnaces (Up to 2800°F)

The PF Series pusher furnace features hydraulic or pneumatic pusher devices which pushes trays or saggers through a high temperature furnace. Single or multiple temperature zones. Air or atmosphere. Typically these use silicon carbide elements mounted over and under the hearth. Electric only.

XLC SERIES

Alloy Muffle Low Dew Point Hydrogen Muffle Furnaces

The XLC Series feature corrugated "D" shaped alloy muffles with water cooled silicone "O" ring seals and insulated plug doors. These are ideal for hydrogen use in such applications as copper brazing, bright annealing of stainless steel, chemical reductions, etc. Because of tight seal, excellent work can often be achieved in inert atmospheres as well. Sizes range from 6" wide by 6" high by 10" deep to 30" wide by 24" high by 68" deep. See the XLC Product Bulletin for specifications.



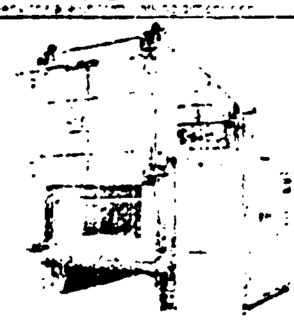
CB SERIES

Carburizing, Carbonitriding, Neutral Hardening Furnaces

The CB Series are specifically designed for carburizing, carbonitriding and neutral hardening. They feature endothermic or nitrogen/methanol atmospheres, automatic carbon control, fan for atmosphere circulation and heavy gauge low voltage Chromel AA elements or gas fired radiant tubes. Maximum temperature is 1850°F.

MODEL	W	H	D	KW	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	24	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

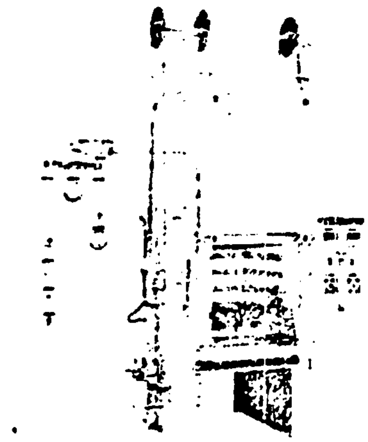
[illegible]



XLN SERIES

Neutral Hardening Furnaces

The XLN Series are modified versions of the XLTF Series. They feature the MPN mixing panel for mixing nitrogen with natural gas, Chromel AA elements, fan and a variety of other options to customize them for this application. See the XLTF Series information for available sizes.



FLOW PANELS

Atmosphere Flow Panels for Combustible Gas

All panels features a wide range of safety features to meet NFPA 86C.

MPH SERIES: This flow panel is for mixing nitrogen or argon with up to 4% hydrogen to make forming gas which is considered non-combustible.

MPN SERIES: This flow control system mixes nitrogen with natural gas for neutral hardening applications.

NM SERIES: This flow panel mixes nitrogen with methanol and natural gas for higher quality neutral hardening or carburizing. Ammonia may be added for carbonitriding. A pressurized methanol supply system can be included.

EN SERIES: This panel controls flow of endothermic gas and back up nitrogen purge. It is used for the same applications as the NM Series.

H2 SERIES. This panel is designed for up to 100% hydrogen. A nitrogen and emergency purge line are included.

AQ SERIES

Automatic Integral Gas Quench Furnaces

The AQ Series is designed to harden air hardening tool steels such as the A or M series under a completely protective atmosphere of nitrogen and natural gas. The quench chamber features a high volume/high pressure quench atmosphere which recirculates through a heat exchanger. There are two temperature ranges: 1800°F and 2200°F for high speed tool steels.

MODEL	W	H	D	KW	MAX LOAD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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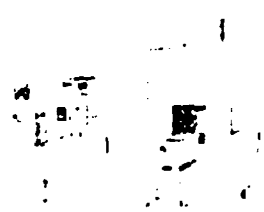


IQ REBUILDS

Rebuilt and Redesigned Integral Oil Quench Furnaces

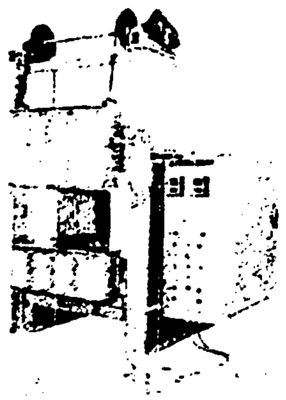
L&L will rebuild, redesign and completely recondition existing integral oil quench furnaces. All new atmosphere controls and control logic using PLCs are typically used. Service includes purchasing of the used equipment (if the customer doesn't already own one), reconditioning or rebuilding all the mechanical components, base and insulation, building new electrical and atmosphere panels, complete in-house testing, start up and training service and brand new equipment warranty. Typically the cost is 1/2 to 3/4 of a new furnace of comparable features and quality.

FW SERIES

2400°F Gas Fired Box/Slot Forging Furnaces

The FW Series features a unique vertical door that allows the furnace to be used as a general purpose box furnace or a slot forging furnace.

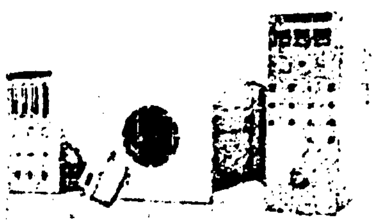
MODEL	W	H	D	BTUs	MAX LOAD
FW 222	24	[illegible]	[illegible]	200,000	600
FW 224	24	24	48	400,000	[illegible]
FW 333	36	30	36	[illegible]	[illegible]
FW 334	35	35	48	[illegible]	[illegible]
FW 336	35	35	72	200,000	[illegible]
FW 444	48	48	48	900,000	[illegible]
FW 446	48	[illegible]	72	1,250,000	[illegible]



TB SERIES

2100°F Tube Furnaces with Uniformity up to ±2°F

The TB Series feature ceramic fiber insulation, molded elements with very even heating and a wide variety of diameters and lengths. A specialized version, the TBU Series, features three zone control for high uniformity. Various tubes and atmosphere systems are available. Vertical configurations are available. Standard diameter of tubes include 1", 2", 3-1/2", 5", 6-1/2", 8", 12", and 14". Typical heated lengths are 12", 24", 36", 48" and 72". However, any length is possible and any diameter up to 60" is possible.



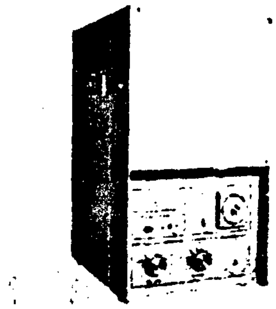
CT SERIES

2800°F Tube Furnaces with Silicon Carbide Elements

The CT Series tube furnaces feature an alumina tube that is heated externally by silicon carbide elements mounted transversely to the tube. Horizontal or vertical mounting.

MODEL	DIA	LENGTH	K.W.
CT 7	1-1/2	7	[illegible]
CT 212	2	12	[illegible]
CT 224	2	24	[illegible]
CT 312	3	12	[illegible]
CT 324	3	24	[illegible]
CT 512	5	12	[illegible]
CT 524	5	24	[illegible]

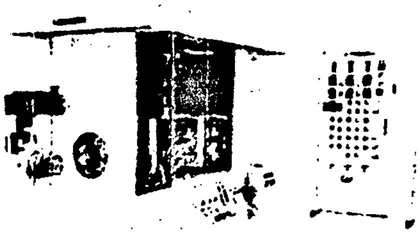
The CT 7 is a specialized version which includes a control cabinet integrated with the furnace and ... alumina tubes and horizontal mounting only.

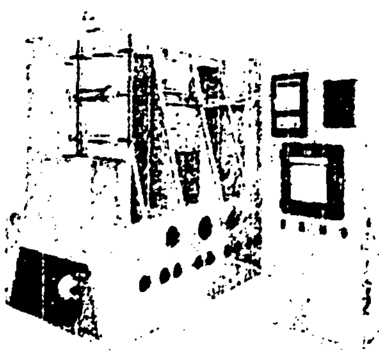


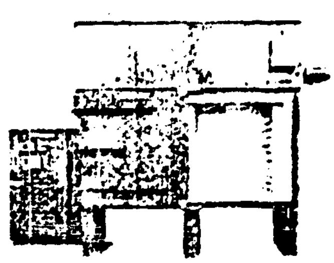
SPECIAL DESIGNS FROM A SPECIAL COMPANY

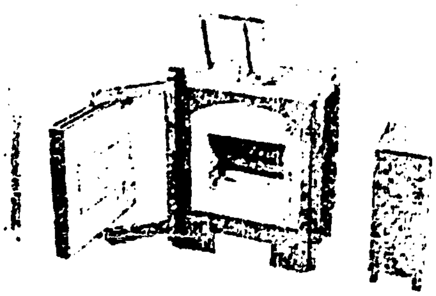
L&L has Engineered and Built Special Furnaces and Ovens for Over 40 years

L&L Special Furnace Co., Inc. has designed many special furnaces, ovens and heat treating systems over the years. All manufacturing and engineering are done in house from one location just south of Philadelphia, PA. L&L sells and services its equipment all over the world, offering start up service as well as emergency repair service. An extensive parts department offers quick response. Great care and attention is given to instructions, wiring diagrams, assembly drawings and support information. L&L is continually updating its product offerings and improving quality. A reputation for sophisticated engineering, quality workmanship and professional service has resulted in a large and growing base of satisfied customers, many of them larger and very particular customers. A few of the many special furnaces we have built are shown here.









☎ 610

NEW AREA CODE

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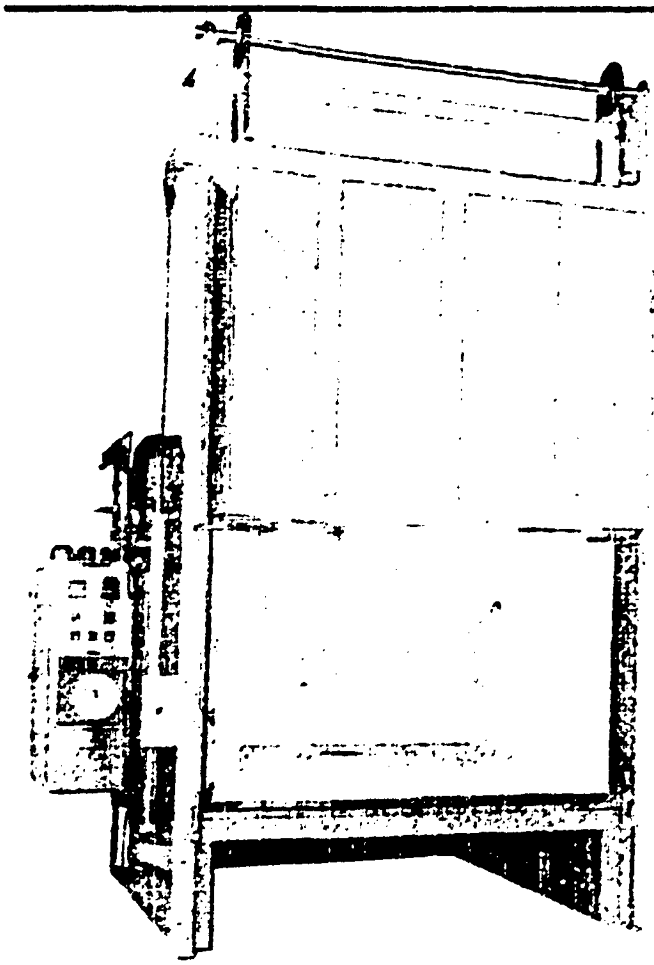

☎ 610
NEW AREA CODE

APPLICATIONS

The XLG furnaces are multi-purpose gas fired box furnaces. They are highly uniform in temperature and feature accurate digital controls and multiple medium velocity (Eclipse (MVTA) proportionally controlled burners with an independent combustion blower. The XLG furnaces can be rated as high as 2400°F (1315°C) although typical rating is 2000°F (1093°C). Connected gas pressure can be as low as 1 PSI. Firing with gas can be more economical than firing with electricity. In addition the circulation of the hot gases, especially with multiple medium velocity burners, promotes good temperature uniformity without the use of high temperature fans. The burners can be adjusted to run lean to provide a slightly reducing atmosphere (although this can not be precisely controlled.) These furnaces are excellent for ceramics processing and most metallurgical work where precise atmosphere control is not required. Systems can be designed with excess air for high uniformity at low temperatures.

FRONT LOADING MULTI-BURNER GAS FIRED BOX FURNACES

XLG SERIES

FEATURES

ECLIPSE MVTA MEDIUM VELOCITY BURNERS

The furnace is heated with three or more Eclipse MVTA (or, in some cases, HVTA high velocity burners.) These typically fire over the load with burner placement balanced to maximize circulation of the combustion products. In some large units they may be configured to fire over and under the load.

FM GAS TRAIN

The gas system includes two hydraulic-mechanical shut off valves, pressure regulator, manual shut off valves, pressure gauges, and pilot system with separate regulator and solenoid shut off. Each burner has individual gas adjustment valves. A proportionating valve, controlled by the combustion air, maintains stoichiometric air-gas ratio. Systems can also be designed to fire with excess air for high uniformity at low temperatures.

COMBUSTION AIR AND BLOWER SYSTEM

Combustion air is provided by a centrifugal combustion blower. A pressure gauge and air pressure switch monitor performance. Each burner has separate orifice plates and butterfly valves for precise balancing of air flow. The control of firing rate is done with a motorized butterfly valve which controls the amount of combustion air relative to a signal from the temperature control.

FLAME SAFETY SYSTEM AND SPARK IGNITOR

Each burner is ignited with a spark plug actuated from the control panel. UV (Ultra Violet) sensors monitor the flame. Before ignition the system goes through a timed purge with the combustion air. Safety interlocks include a combustion air pressure switch and gas high/low pressure switch. Interlocks are annunciated on the panel.

HIGH TEMPERATURE UNIFORMITY

The furnace is ±15°F (±8°C) above 1200°F (650°C) within the working dimensions. High uniformity at lower temperatures can be achieved with excess air.

EFFICIENT CERAMIC FIBER INSULATION

The sides, back, door and top surfaces are typically insulated with 2300°F ceramic fiber modules, 8" thick, 10 lb density, although this is easily modified for different temperature ranges and applications. No asbestos is used. The bottom is insulated with a combination of castable and firebrick. Loads can be directly placed on this strong bottom. Optional castable piers and ceramic, silicon carbide, serpentine or flat alloy hearth plates are available.

HEAVY DUTY CASE WITH INTEGRAL STAND

The furnace case is constructed of heavy gauge steel with structural stiffeners, lifting rings and leveling bolts. The case is primed with a high temperature (800°F) silicone based paint and finished with heat resistant enamel.

COUNTERBALANCED PNEUMATIC VERTICAL DOOR

The standard furnace door has a counterbalanced vertical door with a pneumatic opener and hand or foot operated valve. Double pivoted horizontal doors are optional (standard on 6 and 8 foot high models.)

DIGITAL PID CONTROL SYSTEM WITH HIGH LIMIT

The standard control is a Honeywell UDC 3000 digital PID 3 mode tuning control. A Honeywell UDC 2000 high limit control is also included. All fuses and controls are located in a NEMA 12 panel. The thermocouple is dual Type K with an Inconel protection tube. A limit switch turns down the burners when the door is opened. Control voltage is 120 volts. The furnace is fully fused. Single point power connection.

MEETS NEC, OSHA AND FM CODES

The wiring of the furnace meets the National Electrical Code. The combustion system meets FM standards. IRI standards are available. Furnace meets all OSHA codes in effect at manufacture. Furnace drawings can be submitted to FM or IRI for approval.

FACTORY TESTING, START UP AND INSTRUCTIONS

The furnace is completely tested in our factory up to maximum temperature. A very complete instruction manual is included. A factory technician will start up furnace in your factory and make all adjustments on site.

ONE YEAR WARRANTY

The furnace is warranted for one year.

OPTIONS

- ***RAMP/SOAK PROGRAM CONTROLS***
- ***TEMPERATURE RECORDERS.*** Round and strip chart.
- ***SPECIAL HEARTHS AND LOADERS:*** Castable piers, silicon carbide, alloy hearths, load baskets and serpentine alloy hearths are available. Hydraulic lift fork type loaders are available.
- ***SPECIAL DESIGNS:*** Car Bottoms, Shuttle Types, Elevator Types, Tip Up Types

SPECIFICATIONS

MODEL NUMBER	WORKING DIMENSIONS W	H	D	INSIDE DIMENSIONS W	H	D	OUTSIDE DIMENSIONS OW	OH	OD	TYPICAL BTUS	MAXIMUM LOAD LBS	SHIP WEIGHT
XLG 324	36	24	48	48	48	48	120	148	112	1,200,000	1800	3400
XLG 334	36	36	48	48	60	60	120	172	112	1,200,000	1800	5800
XLG 336	36	36	72	48	60	84	120	172	136	1,500,000	2700	7300
XLG 444	48	48	48	60	72	60	132	186	112	1,500,000	2400	6800
XLG 446	48	48	72	60	72	84	[illegible]	196	[illegible]	2,500,000	3500	8000
XLG 556	60	60	72	72	84	84	144	220	[illegible]	3,500,000	4500	9500
XLG 666	72	72	72	84	96	84	156	150*	136	4,000,000	5400	11,000
XLG 668	72	72	96	84	96	108	156	150*	160	5,000,000	7200	12,200
XLG 888	96	96	96	108	120	108	180	174*	160	6,000,000	9500	15,500
XLG 8810	96	96	120	108	120	132	180	174*	184	7,000,000	12,000	19,300

* These models with 72" and 96" [illegible] must have horizontal doors. Dimensions are in inches. Weights in pounds. BTUs are sized for a particular application. Voltage can be 208, 240, 480, 575 or 380 3 phase. Larger sizes are available however loading is best [illegible] with a car bottom or other [illegible] of this furnace. [illegible] available. Special sizes are available. Specifications subject to change without notice.

L&L SPECIAL FURNACE CO., INC.

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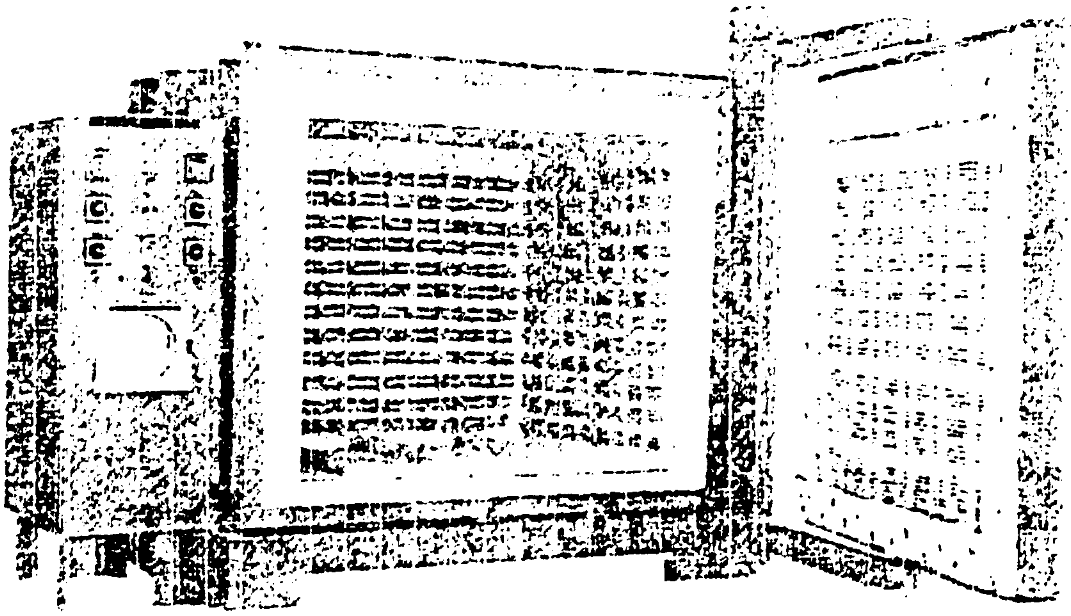

APPLICATIONS

The FB Series Electric Box Furnaces are a general purpose ceramic fiber lined electric box furnace. They achieve high precision by featuring highly accurate controls, mercury contactors for fast cycle times, two zone control (top and bottom), and even spacing of elements. They reach temperatures up to 2200°F with iron-aluminum-chrome elements, and up to 2000°F with the standard nickel-chrome elements. Insulation is a ceramic fiber except for hearth and hearth support.

FEATURES

HIGH TEMPERATURE UNIFORMITY

The furnace is uniform to within ±25°F above 1500°F (800°C). Optional top mounted recirculating fans and multi-zone power controls are available for uniformity of up to ±10°F.

TWO ZONE CONTROL FOR CLOSE GRADIENTS

The elements are divided into top and bottom zones. The control output is routed through two input switches which allow adjustment of the total input to each zone

CERAMIC FIBER LINED LARGE BOX FURNACES TEMPERATURES TO 2200°F (1200°C)

F3 SERIES

EVEN ELEMENT PLACEMENT
Coiled alloy elements are evenly spaced along the sides, back, and door creating an even wall of radiation.

PROPRIETARY CERAMIC ELEMENT HOLDERS
The elements are supported in proprietary high temperature ceramic element holders. These provide perfect support for the coiled elements as well as excellent radiating characteristics. The smooth surface prevents premature failure of the element as it expands and contracts. The holders are kept in place on the insulation walls with specially designed ceramic clamps and screws which fasten to a stainless steel mesh screen which is an integral component of the insulation system.

CERAMIC FIBER INSULATION FEATURES FAST HEAT UP AND COOL DOWN
The sides of the furnace are insulated with 8" of low density ceramic fiber and mineral wool board. The hearth is insulated with a very light weight but tough insulating castable refractory. The top is insulated with 10 pound density 8" ceramic fiber Pyroblocks.

DOOR AND SEAL
The door seal is a folded pad of ceramic fiber blanket, which seals against a rigid ceramic fiber board attached to the case front. The standard furnace door is horizontally opening with a double-pivoted hinge which allows parallelogram opening of the door. This keeps the hot face of the door away from the operator and allows tight sealing of the door. Four hand wheels clamp the door tightly against the front seal. Electrically operated vertical doors are optional.

VARIOUS HEARTHS AND LOADING SYSTEMS
The standard hearth is a flat castable pad. Castable piers on centers for forklift loading are optional. An option for a convenient loading system is a serpentine alloy hearth tray which is loaded into the furnace with a hydraulically operated lifting cart. Other types such as alloy rollers are available.

DIGITAL PID CONTROL SYSTEM
The standard control is a Honeywell UDC 3000 digital PID 3 mode tuning control. All fuses, transformers, contactors, and controls are housed in a NEMA 1 panel. Quiet, long life mercury contactors are standard. Thermocouples are inconel sheathed Type K. Thermocouple break protection is included. Limit switches shut off furnace power if the door is opened. Control voltage is transformed to 120 volts. The control circuit and each power branch circuit are fully fused. Single point power connection.

TESTING AND INSTRUCTIONS
The furnace is power tested to insure proper watt ratings. A complete instruction manual includes easy start up instructions, theory of operation, maintenance instructions, parts list, and a detailed trouble shooting guide. A ladder logic diagram and panel layout are prepared on CAD for easy readability.

WARRANTY
The furnace is warranted for one year except for elements and thermocouples which are warranted for six months. See warranty sheet 0120.

OPTIONS

- ***OVERTEMPERATURE SYSTEM:*** Honeywell UDC 2000 digital high limit back up control with manual reset, back up contactors and separate thermocouple
- ***JIC CONTROL OPTION:*** This includes a NEMA 12 control cabinet, all oil tight switches and a panel mounted fused disconnect switch. Zone switches are percentage timers.
- ***RAMP/SOAK PROGRAM CONTROLS***
- ***TEMPERATURE RECORDERS:*** Round or strip chart.
- ***SCR POWER CONTROL:*** For greater precision. Multi-zoning is available for high uniformity
- ***HIGH TEMPERATURE FANS:*** Temperatures to 1800°F, 2000°F or 2200°F.
- ***ATMOSPHERE BLANKETING:*** Case can be sealed for controlled atmosphere operation.
- ***MANUAL OR POWERED VENTURI VENT:*** A manual or powered venturi can be provided for fast cooling or venting. This can be programmable.
- ***ELECTRIC VERTICAL DOORS:*** The door is counterbalanced with an electric gear motor drive with torque limit safety in case of jams. Floor switch is optional.
- ***HEAT SHIELD:*** For very low case temperatures.

SPECIFICATIONS

MODEL NUMBER	WORKING DIMENSIONS W	H	D	INSIDE DIMENSIONS W	H	D	OUTSIDE DIMENSIONS W	H	D	WORK CU FEET	KW	LOAD WEIGHT	SHIP WEIGHT
FB 333	36	36	36	42	42	42	84	88	68	27	[illegible]	675	4200
FB 334	36	36	48	42	42	54	84	88	81	36	76	900	4600
FB 336	36	36	72	42	42	78	84	88	105	54	100	1350	6300
FB 444	48	48	48	54	54	54	[illegible]	100	81	64	105	1200	5900
FB 446	48	48	72	54	54	78	104	100	[illegible]	[illegible]	[illegible]	1800	7300
FB 555	60	60	60	66	66	66	110	101	93	[illegible]	157	1875	7700
FB 666	72	72	72	78	78	78	128	115	102	[illegible]	[illegible]	2700	10,500
FB 888	96	96	96	102	102	102	152	140	126	512	[illegible]	4900	15800

Dimensions are in inches except for Working Cubic Feet. Weight is in pounds. Standard voltage is 480 [illegible] other voltages are optional. Special sizes are available. Heavier load weights are possible. Outside dimensions are for [illegible] door and [illegible] the side mounted control panel. [illegible] reduce [illegible] working height by [illegible] to 12". Specifications [illegible] change without

The following cautions apply in general to all L&L electric furnaces. In addition there may be specific cautions associated with your furnace. These will be highlighted in **BOLD UNDERLINED CAPITALS.** Be sure to read the entire instruction book and follow these cautions as well as the ones listed here.

DANGER! POWER SUPPLY RATING MUST BE ADEQUATE ACCORDING TO THE SCHEMATIC OR THE WIRING SUPPLY WILL OVERHEAT AND COULD CAUSE A FIRE.

DANGER! DO NOT INTRODUCE ANY COMBUSTIBLE OR FLAMMABLE ATMOSPHERES INTO THE CHAMBER. THIS CAN CAUSE AN EXPLOSION, POSSIBLY LEADING TO SERIOUS INJURY OR DEATH. NOTE: Combustible atmosphere has 4% or more combustibles in it. If you have the inert atmosphere sealed case option see the specific instructions for that.

DANGER! DISCONNECT ALL POWER FROM THE FURNACE BEFORE OPENING THE BACK OF THE FURNACE OR WORKING ON THE ELEMENTS. FAILURE TO DISCONNECT THE POWER CAN RESULT IN ELECTROCUTION. DO NOT TAMPER WITH SAFETY CUTOFF SWITCHES WHICH CUT OFF POWER WHEN THE BACK COVER IS REMOVED.

CAUTION: Power coming into the furnace must be supplied from a fusible disconnect switch located within 6 feet of the unit. If your furnace has the J.I.C. control option you already have a fused disconnect switch mounted on the control panel.

CAUTION: The furnace casing may be hot and could cause a burn injury. This is especially true when the furnace is operated above 2000°F.

CAUTION: The furnace must not be located closer than 36 inches to combustible materials. Operation of the unit closer to combustibles than this distance could result in a fire caused by exposure to heat.

CAUTION: Breathing hot furnace air during operation can cause internal lung and respiratory burns.

CAUTION: Heat resistant gloves should always be worn when loading and unloading the furnace to prevent serious burns from occurring. Protective heat resistant clothing should be worn to protect arms, body, and face.

CAUTION: Read and follow this entire instruction manual. It is the customer's responsibility to make sure that all personnel that use the furnace are familier with this instruction book and the specific cautions and maintenance requirements.

MATERIAL SAFETY DATA SHEET
THE BABCOCK & WILCOX COMPANY
INSULATING PRODUCTS DIVISION

MSD Identification/Trade Name and Synonyms
(NOTE: Labels on products will show individual product trade names)

INSULATING FIREBRICK PRODUCTS:

K-20 IFB
K-23 IFB
K-26 LI IFB
K-28 IFB
K-30 IFB
K-3000 IFB
K-1620 IFB
INSALCOR

SECTION I

Manufacturer's Name
BABCOCK & WILCOX, INSULATING PRODUCTS DIVISION

Emergency Telephone Number
(404) 796-4200

Address (Number, Street, City, State, Zip)
P.O. BOX 923, 2102 OLD SAVANNAH ROAD, AUGUSTA, GEORGIA 30903

Chemical Name and Synonyms
N/A MIXTURE

Formula
N/A

Chemical Family
REFRACTORY INSULATING FIREBRICK

Comments
N/A

SECTION II HAZARDOUS INGREDIENTS

A. AS MANUFACTURED	**WT. %**	**TVL/PEL**
NONE		

B. AFTER NORMAL USE
SEE SECTION IX

SECTION III PHYSICAL DATA

Boiling Point (F)	*N/A*	**Specific Gravity Range (H_2O = 1)**	
Vapor Pressure (mm Hg.)	*N/A*	*0.5 - 1.3*	
Vapor Density (Air = 1)	*N/A*	**Percent Volatile by Volume (%)**	*N/A*
Solubility in Water	*INSOLUBLE*	**Evaporation Rate (= 1)**	*N/A*

Appearance and Odor
POROUS BRICK - NO ODOR.

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Extinguishing Media	**Flash Point (Method Used)**	**Flammable Limit**	
N/A	*N/A*	*N/A*	
Unusual Fire and Explosive Hazards	**Special Fire Fighting Procedures**	**LEL**	**UEL**
N/A	*N/A*	*N/A*	*N/A*

DATE PREPARED: *10/01/85* **DATE REVISED:**

MATERIAL SAFETY DATA SHEET
THE BABCOCK & WILCOX COMPANY
INSULATING PRODUCTS DIVISION

SECTION V HEALTH HAZARD DATA

Primary Route of Entry
INHALATION

Effects of Overexposure
DURING INSTALLATION, IT IS COMMON TO HANDLE AND CUT THIS MATERIAL. THIS PROCESS MAY GENERATE RESPIRABLE NUISANCE DUST. THE TLV/PEL IS 5 mg/cu m (Reference 1984-85 ACGIH TLV Booklet, Page 50). USE OF APPROPRIATE RESPIRATORY PROTECTION AND PROPER VENTILATION IS RECOMMENDED.

Emergency and First Aid Procedures
TERMINATE EXPOSURE

SECTION VI FIRE, EXPLOSIVE AND REACTIVITY DATA

N/A

SECTION VII SPILL OR LEAK PROCEDURES

Recommended Procedure	**Waste Disposal Method**
N/A	ROUTINE HOUSEKEEPING

SECTION VIII SPECIAL PROTECTION INFORMATION

Respiratory Protection (Specify Type)
DUST RESPIRATOR IN COMPLIANCE WITH OSHA STANDARD CURRENTLY 29 CFR 1910.134 (NIOSH APPROVED, AIR PURIFYING, HALF MASK OR FULL FACEPIECE RESPIRATOR WITH APPROPRIATE FILTER PAD OR CARTRIDGE(S))

Ventilation	**Local Exhaust**	FOLLOW OSHA STANDARD 29 CFR 1910.94
	Mechanical (General)	FOLLOW OSHA STANDARD 29 CFR 1910.94

Protective Gloves	**Eye Protection**
RECOMMENDED	GOGGLES/SAFETY GLASSES RECOMMENDED

Other Protective Equipment
AS REQUIRED TO MEET APPLICABLE OSHA STANDARDS.
Material DOES NOT **appear on NTP and/or IAC lists of reports for Carcinogens**

SECTION IX SPECIAL PRECAUTIONS

Precautions To Be Taken After Use and Upon Removal
THIS PRODUCT AS MANUFACTURED IS AN ALUMINOSILICATE WHICH COULD TRANSFORM UPON HEATING TO MULLITE AND CRISTOBALITE (A FORM OF CRYSTALLINE SILICA). REMOVAL OF THIS PRODUCT AFTER USE MAY RESULT IN THE GENERATION OF DUST. REPEATED INHALATION OF RESPIRABLE FREE CRYSTALLINE SILICA DUST MAY CAUSE DELAYED LUNG INJURY (SILICOSIS). THE RECOMMENDED TLV/PEL FOR FREE CRYSTALLINE SILICA IS DERIVED FROM THE FORMULA:

$$\frac{1}{2}\left(\frac{10\ mg/cu\ m}{\%\ Respirable\ quartz + 2}\right)^{*}$$

*(Reference 1984-85 ACGIH TLV Booklet, Page 34). APPROPRIATE VENTILATION SHOULD BE PROVIDED AND PROTECTIVE EQUIPMENT SHOULD BE WORN IN COMPLIANCE WITH OSHA STANDARD CURRENTLY 29 CFR 1910.134 (NIOSH APPROVED, AIR-PURIFYING, HALF MASK OR FULL FACEPIECE RESPIRATOR WITH APPROPRIATE FILTER PAD OR CARTRIDGE(S)).

12/13/93 **MATERIAL SAFETY DATA SHEET** No. 1287

A. P. GREEN INDUSTRIES, INC.
GREEN BOULEVARD, MEXICO, MO. 65265
TELEPHONE NUMBER -- 314-473-3626

SECTION I

PRODUCT NAME: 'SAIRSET 'SAIRSET DC

PRODUCT TYPE: Refractory Mortar

CHEMICAL FAMILY: SiO_2 = 58-61% Al_2O_3 = 32-35% **FORMULA:** Not Applicable
Fe_2O_3 = 1-2% Na_2O = 2-3%

SECTION II

PRODUCT HAZARDOUS INGREDIENTS

CHEMICAL	TLV-TWA	CAS #
Cristobalite (SiO_2) (10-20%)	0.05 mg/m^3* Respirable Dust	14464-46-1
Quartz (SiO_2) (10-20%)	0.1 mg/m^3* Respirable Dust	14808-60-7
Liquid Sodium Silicate (15-22%)	(None)	6834-92-0

*Source: American Conference of Governmental Industrial Hygienists, 1993-1994.

SECTION III

PHYSICAL DATA

SOLUBILITY IN WATER: Nil

SPECIFIC GRAVITY: 2.2 **MELTING POINT:** Not Applicable

APPEARANCE AND ODOR: Buff to gray granular paste; no odor. **pH:** 10 - 12

SECTION IV

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: None

EXTINGUISHING MEDIA: Not Combustible

SPECIAL FIRE FIGHTING PROCEDURES: None

UNUSUAL FIRE AND EXPLOSION HAZARDS: None

SECTION V

HEALTH HAZARD DATA

EFFECT OF OVEREXPOSURE:

EYES: ACUTE: Dust or aggregate particles can cause mechanical irritation. Liquid sodium silicate may cause eye injury or irritation.
CHRONIC: None known.

SKIN: ACUTE: Can cause mechanical abrasion. Liquid sodium silicate can cause skin drying and chapping.
CHRONIC: None known.

INHALATION: ACUTE: Dust, if present, may cause upper respiratory irritation.
CHRONIC: Dust may cause lung damage if inhaled on a long-term basis.

INGESTION: ACUTE: Unknown.
CHRONIC: Unknown.

MSDS
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Section V (continued)
EMERGENCY AND FIRST AID PROCEDURES:

EYES: Immediately flush eyes with water for 15 minutes. Obtain prompt medical attention.

SKIN: Wash exposed areas promptly. Consult physician if irritation occurs.

INHALATION: Remove to fresh air. Seek medical attention.

INGESTION: Contact physician immediately. Do not induce vomiting unless instructed to do so by a physician.

SECTION VI
REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY: None known

HAZARDOUS POLYMERIZATION: Will not occur

SECTION VII
SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Shovel up and place in a container.

WASTE DISPOSAL METHOD: May be disposed of in an approved landfill, in accordance with local, state, and federal regulations.

SECTION VIII
SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION: Use NIOSH approved respirator when working around dried material or when removing this product after service.

VENTILATION: General mechanical ventilation is adequate.

EYE PROTECTION: Goggles or safety glasses with side shields should be worn.

OTHER PROTECTION: Use of rubber gloves and long-sleeved and long-legged clothing protects hands, arms, and legs from skin contact. Safety shoes should be worn to protect feet from accidentally dropped containers of mortar.

SECTION IX
SPECIAL PRECAUTIONS

Warning: This product contains crystalline silica. Prolonged exposure to dust may cause silicosis, a progressive pneumoconiosis, or other respiratory diseases. International Agency for Research on Cancer (IARC) has classified crystalline silica as a Class 2A carcinogen. Its study concluded that sufficient evidence for carcinogenicity exists in experimental animals and that limited evidence for carcinogenicity exists in humans.

NIOSH approved respirators should be worn any time that refractories are torn out after service. While some respiratory hazard and or nuisance dust may exist from the product itself, other foreign substances may warrant additional precautions during tearout and disposal.

This MSDS provides the toxic chemical "SUPPLIER INFORMATION" required under Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and 40 CFR 372. Toxic chemical information, if applicable to the product(s) named, is located in Section II - HAZARDOUS INGREDIENTS section of the MSDS. This information is subject to the toxic chemical reporting requirements of Section 313 and must be included in all MSDSs that are copied and distributed for this product.

This material safety data sheet contains confidential proprietary information and is not to be disclosed to the general public or to competition except as required by law. The information accumulated herein is believed to be accurate but is not warranted to be, whether originating with A. P. Green Industries, Inc. or not. This information is offered solely for use in your evaluation of this product in respect to safety, health, and environmental hazards.

Prepared By: Ellis J. Smith
Title: Senior Technical Consultant
Phone: (314) 473-3392

MSDS Number: 201
Date Prepared: May 1, 1987
Date Revised: November 15, 199.

Thermal Ceramics

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT NAME

Material Name: **Refractory Ceramic Fiber Product**
Common name: RCF: Ceramic Fiber: Man-made Vitreous Fiber (MMVF)
Intended use: High temperature industrial thermal insulation
Trade names: Kaowool®: Cerafiber®: Cerawool®: Cerachem®: Uni-Bloc®: Saber-Bloc®: Quad-Bloc™: Pyro-Fold®: Ultrafelt®: Pyro-Blanket®: Pyro-Log™: Cerablanket®: Z-Blok®: Pyro-Bloc®:
Blanket, Modules, Strips, Bulk, Packing, Insulation, Shapes, Rope

Manufacturer/Supplier

THERMAL CERAMICS INC.
P. O. BOX 923 DEPT. 300
AUGUSTA, GA 30903
Product Stewardship Program 800-722-5681 FAX 706-560-4053

SECTION 2 - COMPOSITION AND INGREDIENTS

INGREDIENT NAME:	CAS NUMBER:	PERCENT:	OSHA PEL:	OSHA PEL: (PROPOSED)	THERMAL CERAMIC
Refractories, fibers, aluminosilicate	142844-00-6	95-100	15 mg/m³ (Total dust) 5 mg/m³ (Respirable dust)	1 fiber/cc*	1 fiber/cc**

* OSHA proposed permissible exposure limit (PEL) in a *Notice of Proposed Rulemaking, Federal Register* H.S. 1178, June 12, 1992
** Thermal Ceramics' recommended exposure guideline (REG) for respirable fibers as an 8 hour time weighted average (TWA) exposure, based on air samples collected and analyzed using NIOSH method 7400(B). Use NIOSH method 0500 for total dust and method 0600 for respirable dust collection and analysis.

(NOTE: See Section 8 of this MSDS for Personal Protection Guidelines)

SECTION 3 - HAZARDS IDENTIFICATION

Possible health effects: Dust and respirable fibers from this product may aggravate existing chronic lung conditions such as bronchitis, emphysema and asthma.

Target organs: Eyes, skin, respiratory system and lungs.

Primary entry route: Inhalation

Acute effects: Upper respiratory physical irritation. Irritation and inflammation to the eyes on contact and to the skin on prolonged contact.

Chronic effects: The International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO), has classified RCF, along with fibrous glasswool and mineral wool as possible human carcinogens (Group 2B) based on sufficient evidence of carcinogenicity in animals but insufficient data in humans. Additionally, IARC classified crystalline silica, which may be found in after-service RCF exposed to temperatures above 1800°F, as probably carcinogenic to humans (Group 2A).

Signs and symptoms of overexposure:

Eye contact: Physical irritation - inflammation

Skin contact: Physical irritation - rash

Ingestion: May cause temporary irritation to the gastro-intestinal tract

Inhalation: Irritation or soreness in throat, nose and respiratory tract

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SECTION 4 - FIRST AID

Eye contact:	Flush with large amounts of water for at least 15 minutes. Do not rub eyes.
Skin contact:	Wash affected area gently with soap and water. Skin cream or lotion after washing may be helpful.
Ingestion:	Do not induce vomiting, drink plenty of water.
Inhalation:	Remove affected person to clean fresh air.

If any of the symptoms persist, seek medical attention immediately

SECTION 5 - FIRE FIGHTING MEASURES

Flash point:	Non-combustible
Extinguishing media:	Use extinguishing media appropriate to the surrounding fire.
Explosion hazards:	None
Fire fighting protective equipment:	Wear full bunker gear including positive pressure self-contained breathing apparatus.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Spill/leak procedures: Avoid creating airborne dust. Follow routine housekeeping procedures. Vacuum only with HEPA filtered equipment. If sweeping is necessary, use a dust suppressant and place material in containers. Do not use compressed air. Personnel should wear gloves, goggles and approved respirator. Avoid clean-up procedures that could result in water pollution.

SECTION 7 - HANDLING AND STORAGE

This product is stable under all conditions of storage. Store in original factory container in a dry area. Keep container closed when not in use. Follow all MSDS/label precautions.

SECTION 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering controls: Use engineering controls such as ventilation and dust collection devices to reduce airborne fiber concentrations to the lowest attainable level.

Protective clothing: Protective gloves, long sleeved shirts, pants and hat are recommended. Wash exposed clothing separately from other clothing and rinse washer thoroughly. To avoid removing fibers and dust from the work area, it is recommended that work clothing be carefully cleaned with HEPA filtered vacuum or disposable coveralls be used.

Eye protection: Goggles/safety glasses with sideshields should be worn.

Respiratory protection: When it is not possible or feasible to reduce airborne fiber and dust levels below the PEL or REG through engineering controls, or until they are installed, employees are encouraged to use good work practices together with respiratory protection. Before providing respirators to employees (especially negative pressure type), employers should 1) monitor for airborne fibers and respirable cristobalite concentrations using NIOSH method 7400(B) and 7500 respectively and select the appropriate respiratory protection based upon the results of that monitoring, 2) have the workers evaluated by a physician to determine the workers' ability to wear respirators, and 3) implement respiratory protection training programs. Use NIOSH/MSHA approved respirators, in compliance with OSHA Respiratory Protection Standard 29 CFR 1910.134 and 29 CFR 1926.103, for the particular hazard or airborne concentrations to be encountered in the work environment

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Minimum Acceptable Respirator Type
When Handling RCF Products

AS-PRODUCED OR "VIRGIN" FIBERS		AFTER-SERVICE FIBERS/CRISTOBALITE	
*CONCENTRATION**	*RESPIRATOR*	*CONCENTRATION**	*RESPIRATOR*
Up to 1 fiber/cc	RECOMMENDED: Disposable dust/mist respirator (e.g. 3M 9900)		
1 - 5 fibers/cc	Half-face, air-purifying respirator equipped with high efficiency particulate air (HEPA) filter cartridges (e.g. 3M 6000 Series)	Up to 5 fibers/cc or Up to 0.5 mg/m^3 respirable cristobalite	Half-face, air-purifying respirator with high-efficiency particulate (HEPA) filter cartridges (e.g. 3M 6000 Series)
5-25 fibers/cc	Full-face air-purifying respirator with high efficiency particulate air (HEPA) filter cartridges (e.g. 3M 7800 with 7255 filters) or powered air-purifying respirator (PAPR) equipped with HEPA filter cartridges (e.g. 3M W3265S with W3267 filters)		Full-face air-purifying respirator equipped with high-efficiency particulate air (HEPA) filter cartridges (e.g. 3M7800 with 725 filters) or powered air-purifying respirator (PAPR) equipped with HEPA filter cartridges (e.g. 3M W3265S with W3267 filters)
Greater than 25 fibers/cc	Full-face positive pressure supplied air respirator (e.g. 3M 7800 with W9435 hose and W3196 regulator)	Greater than 25 fibers/cc 2.5 mg/m^3 respirable cristobalite	Full-face positive pressure supplied air respirator (e.g. 3M 7800 with W9435 hose and W3196 regulator)

* = Eight hour time weighted average (TWA) of concentrations determined by air samples collected and analyzed using NIOSH method 7400(B) for airborne fibers and method 7500 for cristobalite.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	White odorless wool-like fibrous material	*Vapor pressure:*	Not applicable
Boiling point:	Not applicable	*Vapor density:*	Not applicable
Melting point:	> 3200°F (1760°C)	*Specific gravity range:*	2.50 - 2.70
Water solubility (%):	Not soluble in water	*% Volatile by volume:*	0
Chemical family:	Vitreous Aluminosilicate Fibers	*pH:*	Not applicable

SECTION 10 - STABILITY AND REACTIVITY

Hazardous polymerization: None.

Chemical incompatibilities: Hydrofluoric acid, phosphoric acid, strong alkalies.

Hazardous decomposition products: None.

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SECTION 11 - TOXICOLOGICAL INFORMATION

Epidemiology:

Industry epidemiologic investigations of RCF production workers are ongoing.

The preliminary evidence, obtained from employees in RCF manufacturing facilities, is as follows:

1) There is no evidence of any fibrotic lung disease (interstitial fibrosis) on x-ray.

2) There is no evidence of any lung disease among those employees exposed to RCF that have never smoked.

3) A statistical trend was observed in the exposed population between the duration of exposure to RCF and a decrease in some measures of pulmonary function. These observations are clinically insignificant. In other words, if these observations were mac on an individual employee, the results would be interpreted as being within the normal range.

4) Pleural plaques (thickening along the chest wall) have been observed in a small number of employees who had a long duratior employment. There are several occupational and non-occupational causes for pleural plaque. It should be noted that plaques are pre-cancer nor are they associated with any measurable effect on lung function.

Toxicology:

The International Agency for Research on Cancer (IARC) reviewed the carcinogenicity data on man-made vitreous fibers (includir ceramic fiber, glasswool, rockwool, and slagwool) in 1987. IARC classified ceramic fiber, fibrous glasswool and mineral wool (rockwool and slagwool) as possible human carcinogens (Group 2B). IARC's classification of ceramic fiber was based on sufficie evidence of carcinogenicity in experimental animals and inadequate evidence (no data) of the carcinogenicity of ceramic fibers to humans.

A number of studies on the health effects of inhalation exposure of rats and hamsters have recently been completed. In a lifetime n only inhalation study, rats exposed to the Maximum Tolerated Dose of 30 mg/m³ (approximately 200 fibers/cc) developed progres lung damage (interstitial fibrosis) and cancers of the lung and of the pleura (lining of the chest wall and lung). In contrast, hamsters similarly exposed developed interstitial fibrosis and pleural cancer, but no lung cancer. Cancer of the pleura is called mesotheliom:

A multiple dose study in rats (3,9,16 mg/m³; approximately 25,75,115 fibers/cc, respectively) has been concluded after 29 months. These study data demonstrate a dose-response relationship to the biological effects of RCF in rats. There is no RCF related increas lung tumors at 3,9 or 16 mg/m³. A pleural fibrosis and mesothelioma were seen in a single rat in the mid-dose (9 mg/m³) group. In addition, no consistently diagnosed fibrosis was seen below 9 mg/m³. Pulmonary fibrosis was observed at 9 and 16 mg/m³.

SECTION 12 - ECOLOGICAL INFORMATION

Adverse effects of this material on the environment are not anticipated.

SECTION 13 - DISPOSAL INFORMATION

Waste management/ disposal: To prevent waste fibers becoming airborne, a covered container or plastic bagging is recommended. Comply with federal, state and local regulations. Method of disposal: Landfill (reportable quantities (RQ) not applicable). Chemical additions, processing or otherwise altering this material may make the waste management information presented in this MSDS incomplete, inaccurate, or otherwise inappropriate.

RCRA: If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal whether a material containing the product or derived from the product should be classified as a hazardous waste. (40 CFR 261.20-24).

TCLP: As manufactured, refractory ceramic fiber blankets were tested using EPA's Toxicity Characteristics Leaching Procedure (TCLP). Results showed there were no detectable contaminants or detectable leachable contaminants which exceeded the regulatory levels.

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SECTION 14 - TRANSPORT INFORMATION

Department of Transportation (D.O.T.):

Hazard class:	Not regulated	United Nations (UN) Number:	Not applicable
Labels:	Not applicable	North America (NA) Number:	Not applicable
Placards:	Not applicable		
Bill of lading:	Product name		

SECTION 15 - REGULATORY INFORMATION

SARA Title III: This product does not contain any substances reportable under Sections 302, 304, 313 (40 CFR 372). Sections 311 and 312 apply.

OSHA: Comply with Hazard Communication Standard 29 CFR 1910.1200 and 29 CFR 1926.59, Respiratory Protection Standard 29 CFR 1910.134 and 29 CFR 1926.103. Components of this product are considered to be hazardous as defined by the OSHA Hazard Communication Standard.

TSCA: All substances contained in this product are listed in the TSCA Chemical Inventory [Section 8(b)]. Refractories, fibers, aluminosilicate (CAS #142844-00-6) is subject to the TSCA Export Notification Requirements [Section 12(b)].

California: Listed as "Ceramic Fibers (airborne particles of respirable size)" Proposition 65, The Safe Drinking Water and Toxic Enforcement Act of 1986.

SECTION 16 - OTHER INFORMATION

Precautions To Be Taken After Service and Upon Removal:

As manufactured, RCF products are aluminosilicates which may transform upon heating at temperatures above 1800°F to mullite and cristobalite (a form of crystalline silica). Removal of RCF products after service may generate respirable dust. Prolonged/repeated inhalation of respirable free crystalline silica dust may cause delayed lung injury (silicosis). IARC has placed crystalline silica in Category 2A (IARC believes there is sufficient evidence of carcinogenicity in animals but evidence of the carcinogenicity to humans is limited). The OSHA PEL for respirable cristobalite is 0.05 mg/m³. Appropriate ventilation and respiratory protection should be provided in compliance with OSHA Standards.

Definitions:

ACGIH:	American Conference of Governmental Industrial Hygienists
CAS#:	Chemical Abstracts Service Number
EPA:	Environmental Protection Agency
f/cc:	Fibers per cubic centimeter
HEPA:	High Efficiency Particulate Air
mg/m³:	Milligrams per cubic meter of air
MSHA:	Mine Safety and Health Administration
NIOSH:	National Institute for Occupational Safety and Health
OSHA:	Occupational Safety and Health Administration
RCRA:	Resource Conservation & Recovery Act
SARA:	Superfund Amendments and Reauthorization Act
TITLE III:	Emergency Planning and Community Right To Know Act
Section 302:	Extremely Hazardous Substances
Section 304:	Emergency Release
Section 311:	MSDS/List of Chemicals
Section 312:	Emergency and Hazardous Inventory
Section 313:	Toxic Chemicals Release Reporting
TCLP:	Toxicity Characteristics Leaching Procedures (EPA)
TLV:	Threshold Limit Values (ACGIH)
TSCA:	Toxic Substance Control Act
29 CFR 1910.134 and 29 CFR 1926.103:	OSHA Respiratory Protection Standard
29 CFR 1910.1200 and 29 CFR 1926.59:	OSHA Hazard Communications Standard

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![Thermal Ceramics logo] **Thermal Ceramics**

MSDS Number: 201
Date Prepared: May 1, 1987
Date Revised: November 15, 1993

MATERIAL SAFETY DATA SHEET

Label: Sample

PRODUCT SAFETY INFORMATION
REFRACTORY CERAMIC FIBER PRODUCT

WARNING: This product contains a substance which has been identified by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans.

Avoid breathing fiber particulates and dust

RISKS:
- Possible cancer hazard by inhalation
- Cristobalite (crystalline silica) formed at high temperatures (above 1800°F) is classified by IARC as a probable human carcinogen
- May cause temporary irritation to eyes, skin and respiratory tract

PRECAUTIONARY MEASURES
- Minimize airborne fibers with engineering controls
- Wear a NIOSH/MSHA approved respirator
- Wear long sleeved loose-fitting clothing, eye protection, gloves
- Wash work clothing separately and rinse washing machine after use

FIRST AID MEASURES:
Eyes: flush with water. Skin: wash with soap and warm water. Ingestion: do not induce vomiting. Get medical attention if gastrointestinal symptoms develop. Inhalation: remove to fresh clean air.

If any of the above irritations persists seek medical attention immediately

FOR ADDITIONAL PRODUCT INFORMATION AND WORK PRACTICES REFER TO THE MATERIAL SAFETY DATA SHEET (MSDS).

THERMAL CERAMICS
P.O. Box 923 MS 300 Augusta, GA 30903 USA
No. 1-0991 [illegible]

RENSEIGNEMENTS SUR LA SÉCURITÉ DES PRODUITS
PRODUIT DE FIBRE CÉRAMIQUE REFRACTAIRE

ATTENTION: [illegible]

RISQUES: [illegible]

MESURES PRÉVENTIVES: [illegible]

PREMIERS SOINS: [illegible]

[illegible]

THERMAL CERAMICS
[illegible]

INFORMACION SOBRE SEGURIDAD DE PRODUCTO
PRODUCTO DE FIBRA CERAMICA REFRACTARIA

AVISO: [illegible]

RIESGOS: [illegible]

MEDIDAS DE PRECAUCION: [illegible]

MEDIDAS DE PRIMEROS AUXILIOS: [illegible]

[illegible]

THERMAL CERAMICS
[illegible]

Revisions: Replaces revision dated December 1, 1992. Section 2: ingredient name revised; Section 8: protective clothing reworded; Section 15: updated information; and other minor editorial changes.
Label: 01-0991 "Refractory Ceramic Fiber Product"

Material Safety Data Sheet

partek
Partek Insulations, Inc
P.O. Box 1127
Phenix City, AL 36868

Partek Insulations, Ltd
PO Box 2079
Sarnia, Ontario N7T 7L4
Canada

Date Issued: August 11, 1989
Emergency Phone: 1-800-265-7514
Information Phone: (519) 336-7770
(205) 297-0100

PRODUCTS

Rocflex Products
Rocboard Products
Rocblanket Products
Marine Products
Bulk Fiber Bales or Bags
Cryogenic Insulation
Paroc 1200 Pipe Insulation Products
Hilcover Pipe Insulation Products
Paroc UHDS Pipe Insulation
Pargro® Slabs
Pargro Blocks
Pargro Cubes
Pargro Rock Wool
Pargro Pearwool™

1. PRODUCT INGREDIENTS

	OSHA-PEL	ACGIH-TLV	CAS #
a) Man Made Mineral Fiber	Total $15 mg/m^3$ Respirable $5 mg/m^3$	Total $10 mg/m^3$ Respirable $5 mg/m^3$	None assigned
b) Urea extended phenol formaldehyde resin-cured	none	none	25104-55-6
c) For ASJ jacketed products only, adhesive contains ethane-vinyl acetate copolymer	none	none	none assigned

2. PHYSICAL CHARACTERISTICS

Boiling Point:	N/A	**Odor:**	Faint resin odor
Vapor Pressure (mm Hg):	N/A	**Specific Gravity (H_2O=1):**	Var.
Vapor Density (Air=1)	N/A	**Melting Point:**	2000°F
% Solubility:	Nil	**Evaporation Rate:**	N/A
Appearance	Yellow-beige, may be faced		

3. FIRE AND EXPLOSION HAZARD DATA

Flash Point:	N/A
Flammable Limits:	LEL: N/A
Autoignition Temperature:	N/A
Extinguishing Media:	Use media appropriate to the surrounding fire conditions.
Special Fire Fighting Procedures:	Treat as residential building materials.
Unusual Fire and Explosion Hazards:	The facing on faced products may burn and care should be exercised when working around an open flame. The organic binder and the facing will emit toxic fumes and smoke when oxidized and ventilation is recommended on initial equipment start-up.

4. REACTIVITY DATA

Stability:	Stable
Incompatibility:	Hydrofluoric Acid
Hazardous Polymerization:	Will not occur
Conditions to Avoid:	None in designed use.
Hazardous Decomposition or By-Products:	Carbon Dioxide, Carbon Monoxide, Hydrocarbon particles, Carbon-Hydrogen-Nitrogen and Nitrogen-Oxygen compounds.

5. HEALTH HAZARD DATA

Routes of Entry: Inhalation, skin and eye contact.

Acute Effects: Man Made Mineral Fibers (MMMF) are a mechanical irritant to skin, eyes and upper respiratory system.

Chronic Effects: Extensive medical-scientific research has been conducted into the health aspects of mineral fiber over the past 50 years. The International Agency for Research on Cancer (IARC), an agency for The World Health Organization (WHO) has reviewed this research. The research has included studies of over 50,000 workers employed in the industry, and animal studies.

The animal studies showed that mineral fiber was not a carcinogen by inhalation. Malignant tumors were produced in animals when large doses of mineral fiber were implanted surgically or injected into the chest or abdomen; bypassing the animal's natural defense mechanisms. As a result, IARC has classified mineral fiber in group 2B, "possibly carcinogenic to humans". No increased risk has been demonstrated through inhalation experiments, even at doses of 3000 f/ml over a two year period.

The results of human studies showed somewhat higher risk of lung cancer among workers employed in the industry during the early days of production (1930-1950). A variety of carcinogens used at the time and the lack of dust-suppressing agents contributed to the hazard.

The National Toxicology Program (NTP) and the Occupational Safety and Health Administration (OSHA) do not list or regulate mineral fiber as a carcinogen.

6. EMERGENCY AND FIRST AID PROCEDURES

Eye Contact: Flush with copious quantities of water. Contact a physician if irritation persists.

Inhalation: Remove to fresh air and drink water.

Skin Contact: Cleanse with cold water, then warm water and soap.

Ingestion: Not likely, contact physician if it occurs.

7. RECOMMENDED WORK PRACTICES

Wear Loose Clothing: Wearing long-sleeved shirts and blouses, loose at the neck and wrists, along with long pants and caps will protect skin areas from coming in contact with mineral wool fiber. Loose clothing prevents fiber from rubbing into the skin. Depending on job conditions, gloves may be necessary.

Prevent Airborne Dust: Dust collection systems should be used whenever mineral wool fiber exposures may exceed either established dust standards or recommended fiber standards. Operations such as sawing, machining and/or blowing mineral wool fiber have the greater potential for high exposures.

Protect Eyes: Safety glasses, goggles or face shields should be worn whenever mineral wool fiber materials are being applied overhead or in areas where loose particles or fibers may get into the eyes.

Don't Rub or Scratch Skin: If mineral wool particles and fibers accumulate on exposed skin areas, do not rub or scratch. Remove the material by washing the skin thoroughly but gently with warm water and mild soap. Using a good commercial skin cream or lotion after washing may be helpful.

Wear Respirators: If there is a possibility that airborne mineral wool fiber concentrations may exceed safe working levels or if respiratory discomfort is experienced, respirators should be worn. Acceptable respirators are those specifically approved by NIOSH for protection against dusts. Examples are 3M 8710 (9910), etc. An appropriate fit-testing program must be incorporated in the respiratory protection program.

Wash Work Clothes Separately: Work clothing worn in areas where exposure to mineral wool fiber is possible should be washed separately from other household laundry to prevent fiber from being transferred to other clothing. Rinse the washing machine thoroughly before it is used again. If there is a lot of fiber on clothing, it is best to presoak and rinse the garments first, prior to washing.

Keep Work Areas Clean: Avoid unnecessary handling of scrap materials by keeping waste disposal equipment as close to working areas as possible. Do not let scrap material and debris pile up on floors and other surfaces. Follow an organized housekeeping program at all times.

8. ADDITIONAL INFORMATION

Acronyms used in this MSDS:

ACGIH: American Conference of Governmental Industrial Hygienists

CAS#: Chemical Abstracts Service Number

f/ml: Fibers per milliliter

IARC: International Agency for Research on Cancer

LEL: Lower Exposure Limit

MSHA: Mine Safety and Health Administration

N/A: Not Applicable

NTP: National Toxicology Program

OSHA: Occupational Safety and Health Administration

PEL: Permissible Exposure Limit

TLV: Threshold Limit Values

WHO: World Health Organization

Tech Data

Health and Safety Aspects of Refractory Ceramic Fibers

Refractory ceramic fiber is a synthetic amorphous glassy alumina silica product which is created from molten masses of raw materials under highly controlled conditions.

Industrial Insulations uses such fiber from a number of manufacturers to produce INDO-FORM® vacuum-formed materials, I-CUBE® and Z-BLOK® fiber modules, and a variety of fabricated parts from blanket and felt.

Refractory ceramic fiber (RCF) has been produced in commercial quantities for about 25 years. Because of this relatively short history, it has been deemed necessary to establish through testing whether or not the health effects of these fibes are identical to those reported for glass and rockwool fibers. The RCF industry, through the auspices of the Thermal Insulation Manufacturers Association (TIMA), is sponsoring animal inhalation studies as well as epidemiological studies of workers in the industry. Until such time as definitive answers are available, it is advisable to follow certain common sense work practices designed to minimize exposure. These recommendations and the reasons for them will be covered in appropriate sections of this publication.

Skin Irritation

Refractory ceramic fiber and most glass fibers are very similar in their ability to cause skin and upper respiratory irritation. ***SKIN IRRITATION*** is experienced by some workers in refractory fiber manufacturing facilities as well as some people working with refractory fiber-containing materials. This skin irritation and possible inflammation is a mechanical reaction due to sharp, broken ends of fiber that rub or become embedded in the outer layer of the skin. Skin reactions vary directly with the size and the stiffness of the fiber handled, with fibers of large diameter (greater than 5 micrometers) being more likely to cause irritation and itching. Irritation normally does not persist for any length of time and can be relieved by washing exposed skin areas gently in warm water with mild soap.

Some individuals may be more sensitive to irritation from refractory ceramic fiber than are others, and a relatively small number may be forced to seek other types of employment. The vast majority of workers, however, can control skin irritation by following the work practices outlined at the end of this bulletin.

Upper Respiratory Irritation

It is possible that some workers may experience temporary ***UPPER RESPIRATORY IRRITATION*** (that is, scratchiness or burning of the nose or throat) if airborne refractory fibers are generated during manufacture or handling of refractory fiber-containing products. Like skin irritation, upper respiratory irritation is a mechanical reaction to sharp, broken fibers. It is not an allergic reaction and the irritation does not persist.

Unprotected exposures to high concentrations of airborne refractory ceramic fiber may produce a transitory condition, usually manifested by coughing or wheezing. Careful attention to housekeeping and proper work practices can effectively control airborne refractory ceramic fiber concentrations to prevent this upper respiratory irritation. The effects subside soon after the worker is removed from exposure and have no known long-lasting impact on health.

After Service

Refractory ceramic fiber which has been in service at elevated temperatures (greater than 1000°C) may undergo partial conversion to cristobalite, a form of crystalline silica which can cause respiratory disease (silicosis). This is a consequence of the crystallization or devitrification of the fibers which occurs at high temperatures. The amount of cristobalite which is formed, the size of the individual crystallites and the nature of the matrix in which they are embedded are all a function of the temperature and the length of time the fiber has been heated.

Under normal use conditions, refractory ceramic fiber will generally be exposed to a temperature gradient. Consequently it is most probable that only the fiber nearest the hot surface will have an appreciable cristobalite content. It is also possible that the devitrified cristobalite-containing fiber will be more friable and therefore may generate a larger amount of dust when fiber is removed from a high temperature application. Experiments have not yet been conducted to ascertain whether or not these devitrified fibers are biologically active in animals.

For these reasons particular care should be taken during the "tear-out" of refractory ceramic fiber linings to minimize generation of dust. Adherence to proper methods of dust suppression and control is imperative. The most prudent approach is to treat devitrified fibers as free crystalline silica. Even with adequate control, it is recommended that a respirator approved by NIOSH for protection against pneumoconiosis-producing dusts be used by all workers in the area during removal operations.

Medical and Scientific Studies

There are no known published reports in medical literature dealing with the health experience of people who work with refractory ceramic fibers. Two studies, one in Europe and the other in the United States, are in the initial planning stages to study the health of workers involved in the manufacturing of refractory ceramic fibers. Initial results from those studies will be available in three to five years.

There are two known investigations which have studied the effects of refractory ceramic fibers on animals. An investigation by Davis, et al. in Edinburgh has been completed and published[1]. The other study is nearing completion at the Los Alamos National Laboratories[2] and should be available for publication within the next year.

Summaries of the results of the Davis study and an interim report of the Los Alamos study will be covered below.

In his experiments, Davis injected refractory ceramic fibers into the abdomens of 32 rats. Intraperitoneal injection of fiber bypasses all of the animals' natural defenses and is used as an indicator of the relative biological activity of fibrous materials, although it does not duplicate any type of human exposure. In this experiment, three of the 32 animals developed primary abdominal tumors. Depending on the dose, scientists have found some tumor formation when injecting virtually all types of fibers directly into the abdomen. Such results from intraperioneal injections have been found no matter what the experience has been in inhalation experiments.

Davis also exposed forty-eight rats to refractory ceramic fiber by inhalation for seven hours a day, five days a week, over a period of 224 days. The airborne dose of fibers longer than 5 microns was reported to be 95 fibers/cc.

Animals sacrificed at the end of the study were reported to have an average of 5% pulmonary fibrosis. At the end of the study, eight of the rats were found to have tumors with three animals demonstrating lung carcinomas.

The fibrosis and carcinoma found in the Davis study by inhalation were not expected and clearly point to the need for further study, while raising the normal level of concern.

In 1979, a large scale animal exposure experiment was begun at the Los Alamos National Laboratories involving several types of man-made fibers, including refractory ceramic fiber. In the Los Alamos study, two animal models were used—rats and hamsters. The rats were of a different strain than the ones used in the Davis study mentioned above. The Los Alamos study is not yet complete. Results to date concerning refractory ceramic fiber will be summarized here and updated when the study is completed.

To date, inhalation experiments involving rats show no cancer or fibrosis in twenty-five animals examined. this conflicts sharply thus far with the Davis study. Inhalation experiments on hamsters showed one cancer (mesothelioma) in fifty animals but no fibrosis was observed. One of 157 control animals developed a spontaneous tumor without exposure to fibers. The exposures were conducted at 200 f/cc, 6 hours a day, 5 days a week, for 24 months.

The researchers at Los Alamos also performed intraperitoneal injections of refractory ceramic fiber using both hamsters and rats. Most of the hamsters did not tolerate the initial injection of the fiber into their abdomens and died immediately after injection. Of the five animals so far reported who survived the injection, no tumors were found. Nineteen of the twenty-two rats examined developed tumors (primarily mesotheliomas) after intraperitoneal injection of refractory ceramic fiber. This result was very different from the results obtained by Davis.

While the results from the Davis and Los Alamos studies are conflicting in many ways, there is little doubt a higher level of caution now exists about the possible health implications of exposure to refractory ceramic fiber. In order to help clarify some of the uncertainties raised, new studies have been designed and funded by TIMA to study the human experience as well as further animal studies with refractory ceramic fibers. This effort will begin in late 1985 and begin producing results in three to five years. Until more is known about the possible health effects of refractory ceramic fiber, care should be taken when using these products as detailed in this document.

Recommended Handling Procedures—Occupational Exposure Guidelines/Limits

Refractory ceramic fiber (RCF) is not currently regulated in the occupational environment by any Federal or State health agency. Industrial Insulations and others have established a workplace exposure guideline (WEG) of 2.0 fibers/cubic centimeter (f/cc) as a result of the medical and scientific findings available at this time. The WEG refers to an airborne concentration of a substance, time weighted for a 7 to 8 hour workday and a 40 hour workweek, under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. No employee should work without protection in environments where the airborne concentrations exceed 10 f/cc even for short periods of time.

Industrial Insulations is monitoring the fiber dust levels in its plants and is committed to maintain levels well below 2.0 fibers/cc. In most operations levels below 0.5 fibers/cc will be maintained.

Industrial hygiene monitoring data obtained under typical field conditions indicate that in confined areas with poor exhaust ventilation it is entirely possible to exceed the WEG of 2.0 f/cc. In such situations, temporary exhaust ventilation should be installed. If this is not feasible, the use of respiratory protection and specified work practices must be required, as detailed elsewhere in this document.

Refractory ceramic fiber poses an additional health concern after the product has been in service. Crystalline silica in the form of cristobalite is formed. Typically, bulk material contains greater than 20 per cent cristobalite while respirable gravimetric samples contain greater than 15 per cent cristobalite. Cristobalite exposures may cause lung disease (silicosis) if overexposure occurs. The Occupational Safety and Health Administration (OSHA), United States Department of Labor regulates exposures to cristobalite under 29 CFR 1910.1000, table Z-3 - Mineral Dusts. One half the value calculated from the mass formula, $(10 mg/m^3) / (\%SiO_2 + 2)$, is used to determine the appropriate permissible exposure limit, i.e. 18% cristobalite $\frac{1}{2}$ $(10)/(18 + 2) = 0.25\ mg/m^3$.

Recommended Work Practices

The procedures recommended in the following section are good practices that apply when working where all types of dust can be generated. However, even though it is thought that they apply in only a fraction of the conditons expected with the use of RCF products, some recommendations are given for work environments where industrial hygiene measurements exceed values given elsewhere in this document. Also, some recommendations are only applicable to after service work with these products.

Loose Clothing. Wearing long-sleeved shirts and blouses, loose at the neck and wrists, along with long pants and caps will protect skin areas from coming in contact with refractory ceramic fiber. Loose clothing also helps prevent fiber from rubbing into the skin. Depending on job conditions, gloves may be necessary.

Minimize Dust. Mechanical dust collection systems should be used whenever refractory ceramic fiber materials are machine sawed or sanded. Handling and cutting should be done in a manner that will create the least amount of airborne dust.

Skin Irritation. If refractory ceramic fiber particles accumulate on exposed skin areas, do not rub or scratch. Remove the particles by washing the skin thoroughly but gently with warm water and mild soap. Using a good commercial skin cream or lotion after washing may be helpful.

Eye Protection. Safety glasses, goggles, or face shields should be worn whenever refractory ceramic fiber materials are being applied overhead or in areas where loose particles may get into the eyes.

Respirators. Respiratory protection must be worn to protect against breathing air contaminated with potentially harmful materials such as refractory ceramic fiber and cristobalite. Acceptable respirators are those approved by NIOSH for usage in specific airborne concentrations.

Refractory Ceramic Fiber Exposure Respirators

Respirator users should be instructed as to the proper use of respirators and their limitations, and must be fit-tested to assess the quality of fit. To test the respirator, cover the air inlets with the palm of the hand, inhale so the facepiece collapses slightly, then hold breath for a few seconds to see that it remains collapsed and there are no leaks. Another method is to place a substance with a distinct odor or taste near the respirator seal. It should be undetectable if the respirator fits well.

Disposable respirators should be discarded when soiled or when breathing resistance is noticed by the wearer. For exposures in the 2-5 f/cc range, disposable respirators such as the 3M® Model 8710 are appropriate. Non-disposable types must be regularly cleaned, inspected and maintained.

A wearer of respiratory protection experiencing breathing difficulty while using respirators should be evaluated by a physician to determine the ability of the worker to wear a respirator.

Personal Protective Equipment. In work situations in which engineering controls and/or local exhaust ventilation are either technically not feasible or insufficient to reduce the airborne concentrations of refractory ceramic fibers to below a time weighted average of 2 f/cc, the following clothing guidelines are recommended:

1. Special clothing. Provide and require the use of special clothing, such as coveralls or similar whole-body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of refractory ceramic fibers which exceed a ceiling of 10 f/cc. Provide changing rooms for employees working regularly in such an environment.

2. Clothes lockers. Provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from work clothes.

3. Laundering. Laundering of clothing contaminated with refractory ceramic fibers shall be done so as to prevent the release of airborne fibers in excess of the 2.0 f/cc WEG.

Housekeeping. Avoid unnecessary rehandling of scrap materials by keeping waste disposal equipment as close to working areas as possible. Don't let scrap material and debris pile up on floors and other surfaces. Follow an organized housekeeping program at all times. Vacuum dust with equipment fitted with HEPA filter. If sweeping is necessary, use a dust suppressant.

Waste Management. Wastes generated during application, demolition, breakage or spillage are not hazardous wastes as defined by RCRA (40 CFR Part 261). Comply with federal, state and local regulations. Method of disposal-landfill. RQ-N/A.

Footnotes

1. J.M.G. Davis, J. Addison, R.E. Bolton, K. Donaldson, A.D. Jones & A. Wright, "The Pathogenic Effects of Fibrous Ceramic Aluminum Silicate Glass Administered to Rats by Inhalation or Peritoneal Injection," Biological Effects of Man-made Mineral Fibers, Vol. 2, p.303.

2. D.M. Smith, Principal Investigator; Interim Progress Report to Medical Scientific Committee of TIMA. Personal communication dated March 29, 1985.

INDUSTRIAL
INSULATIONS
INC.

13300 E. Nelson Ave
City of Industry, CA 91746 USA
(818) 369-1061
Telex [illegible]

BE SURE YOU INSPECT THE FURNACE AS SOON AS IT ARRIVES. ANY CLAIMS FOR DAMAGE MUST BE MADE IMMEDIATELY. IT IS THE CUSTOMER'S RESPONSIBILITY TO COLLECT FROM THE INSURANCE COMPANY IF THERE IS ANY DAMAGE.

In inspecting a shipment:

(1) Count all the cartons and compare with the number shown on the freight bill and the Bill of Lading.
(2) Look at the name on each carton. Is it addressed to you?
(3) In case of damage or missing cartons, before you sign the freight bill, write a full description of the breakage or damage or shortage on all copies of the freight bill.
(4) Make your notations as specific as possible to protect yourself in the event that concealed damage is subsequently discovered.
(5) Open all cartons as soon as possible.

CLAIMS FOR DAMAGED OR LOST FREIGHT: The Bill of Lading is an acknowledgement by the transportation company of the receipt in good condition of the shipment covered by the invoice. Once the freight company has accepted the goods from the manufacturer, they are insured, and if damage should occur, full liability is with the carrier and not the manufacturer. The consignee must file a claim directly with the carrier for any damages occurring during shipment or final delivery. Because safe delivery of a shipment is the responsibility of the carrier, it is imperative that you inspect the shipment at the time of arrival before signing the freight bill. If you sign a clear delivery receipt (one signed without exceptions) and later find a shortage, or damage, you will be liable.

CONCEALED DAMAGE: In case of concealed damage, save all boxes and packing material, and contact the transportation company immediately and ask for an inspection by the transportation company's agent. If the request is made by phone, you must confirm it in writing. This request should be made within 15 days after delivery. This is necessary before filing a claim. At time of inspection, require the inspector to give you a concealed damage report, stating the condition of goods he has examined. It is his duty to do this and you should insist upon it. Unless you do this, the transportation companies will not entertain any claim for damage. File claim promptly, but in no case later than 9 months from date of delivery. The concealed damage report, along with copies of the invoice, the Original Bill of Lading, and the Freight Bill will properly support a claim.

LOOKING FOR CONCEALED DAMAGE: Inspect all bricks (especially the roof) after removing the interior brace. Look for hairline cracks. Inspect all components inside the control panel. Is everything tight?

REASSEMBLY AND PREPARATION OF XL, XT, AND TF FURNACES

CONTROL PANELS: On many furnaces with separate control panels, the panels have been demounted. Attachment is fairly straight forward. All wires are marked for proper connection in the back of the furnace. See the wiring diagram.

LEVELING: Take off the skids and insert bolts in the welded nuts in the base of the legs. Level furnace. This is important because your work could possibly roll off an unlevel hearth and damage the furnace lining.

DOOR PREPARATION: Most furnaces are shipped with the door attached; door preparation in these cases is straightforward. Simply remove any packing material and tighten any clamping or hinge hardware that may have worked loose in shipment.

BE SURE THAT THE HARDENED BOLTS THAT GO INTO THE DOOR AND ACT AS HINGE PINS ARE IN AS DEEP AS THEY CAN GO AND THAT THE LOCK NUTS ARE VERY TIGHT. See Routine Maintenance Procedures.

See Vertical Door Installation Instructions located in the OPTIONS INSTALLATION Section if the furnace is provided with this option.

INSTALLING HEARTH: (This applies to standard cordierite ceramic hearths, silicon carbide hearths, and alloy hearths. See specific sections or separate instructions on special hearths).

Hearth must be raised above the bottom elements at least 1-1/2". The more space provided, the better the uniformity will be. If the hearth is not raised above the elements, the elements will overheat and the hearth could crack.

Included with the hearth are ceramic standoffs. Evenly distribute the load of the hearth on the standoffs. If your loading is unusually heavy or if you break a hearth it is suggested that you purchase more of these standoffs. See below for normal hearth loadings. The standoffs may be cemented to the bottom firebrick.

Also, you may choose to use hard firebrick to support the hearth. These can be cut and rubbed to make leveling of the hearth easier. When hearth is in place, final leveling may be done with the furnace leveling bolts. You may want to cement into place hard firebrick bumpers along the sides and in the back to keep the hearth plate from shifting. Be careful if you do this so that the side and bottom bricks are not cemented together and that no elements are covered. You can purchase "Hard Firebrick" and "Refractory Cement" direct from L & L. Hearth should be placed equidistant from sides, back and door so that there is an air space betwen hearth and all sides.

REASSEMBLY AND PREPARATION OF XL, XT, AND TF FURNACES

STANDARD CORDIERITE HEARTHS FOR XL, XT, AND TF SERIES FURNACES

MODEL	NO. OF PLATES	PLATE SIZE	STANDARD HEARTH LOADING	NO. OF HEARTH SUPPORTS
XT 12	1	11" X 11"	125 LBS.	4
XT 15	1	13" X 13"	175 LBS.	5
XT 18, XT84	1	16" X 16"	250 LBS.	6
XT24, XT 28	2	11" X 22"	500 LBS	6
XT 30, XT 34	4	13" X 13"	700 LBS.	5
XT 36, XT 48	4	16" X 16"	1000 LBS.	6
XL 524	1	13" X 22"	300 LBS.	6
XL 814, XL 824, XL 418	1	16" X 22"	350 LBS.	8
XL 816, XL 836	2	16" X 16"	500 LBS.	12
XL 848	3	16" X 16"	750 LBS.	18
XL 236	3	11" X 22"	750 LBS.	18
XL 214, XL 244	2	11" X 22"	500 LBS.	12
XL 248	4	11" X 22"	1000 LBS.	24
XL 272	6	11" X 22"	1500 LBS.	36
TF 3248, TF 3348	4	13" X 22"	1200 LBS	24
TF 3272, TF 3372	6	13" X 22"	1800 LBS.	36
TF 3436, TF 3636	4	16" X 16"	1000 LBS.	24
TF 3448, TF 3648	4	16" X 22"	1400 LBS.	32
TF 3472, TF 3672	6	16" X 22"	2100 LBS.	48

For odd sized hearths or larger ones figure approximately 1 lb. per square inch loading.

MISCELLANEOUS PREPARATION: Vacuum out furnace interior for any dust particles that may have come loose during shipment. Pay particular attention to keeping dust out of element holders. Vacuum out control panel to make sure that any metaldust left over from manufacturing is removed. **IF THERE IS ANY METAL DUST IN THE CONTROL PANEL IT MUST REMOVED TO PREVENT A POSSIBLE SHORT CIRCUIT.**

OPTIONS: Install all unattached optional equipment per specific instructions found in the OPTIONS INSTALLATION Section. These include flowmeter/regulator system, finishing inert case, installing recirculation muffle, etc.

NOTE: Do not place hearth standoffs directly over elements.

NOTE: Be sure to protect bottom elements from any electrically conductive material that may fall into the elements. (such as carbon, steel, copper, etc.)

ELECTRICAL HOOKUP

Read and understand the wiring diagram(s) included with the instructions. The wiring information is normally split into the Heating Element Schematic and the Controls Schematic. All information relating to actual power requirements is included in the Heating Element Schematic. **CAUTION:BE SURE THAT POWER SUPPLY RATING IS ADEQUATE ACCORDING TO THE POWER REQUIREMENTS SHOWN ON THE SCHEMATIC. OTHERWISE, YOU WILL OVERHEAT YOUR WIRING SUPPLY AND THIS COULD CAUSE A FIRE.**

Operation of the controls is described in the Sequence of Operations written on the Controls Schematic. All Control Schematic drawings include the overtemperature control and safety contactor option; if your furnace was ordered without this, disregard the components and operations description shown on the Schematic. Should this option ever be desired, the Control Schematic shows how to hook it into the system. A kit is available from the factory for this. All interconnections between the Controls and the Heating Elements are as described in the wiring diagram(s).

All information concerning voltage, amperage, motor ratings, temperature limitations, serial number, etc., is listed on the data plate. This is normally located on the back of the furnace or control panel.

VERY IMPORTANT: Check control transformer jumpers for proper hook up. These are normally set for the nameplate voltage at the factory, but in some cases could inadvertently have been set for 240 volts. If, for instance, this happened for a 480 volt furnace, the transformer will fail. Output is always 120 volts, unless stated elsewhere in Schematic.

Check inside control panel to make sure there is no metallic dust from manufacturing. If so vacuum out control panel.

In all furnaces with side mounted control panels, all power connections are in the panel. Bring in power through the top or side of the panel and connect to the power terminal. Power coming in must be supplied from a fusible disconnect switch located within 6 feet of the furnace (unless furnace is supplied with this already as on the J.I.C. Control System Option.)

FIRST FIRING AND CURING FOR FURNACES WITH CASTABLE HEARTHS

After proper hook-up to power, check control system for proper operation at low temperature ranges (below 200°F.) Make sure heating circuits are drawing the proper current with an ammeter.

Make certain that control thermocouples are immersed into the firing chamber at least 1-1/2". **CAUTION: IF THERMOCOUPLES ARE NOT MEASURING TEMPERATURE INSIDE THE FURNACE CHAMBER THEN THEY COULD CAUSE THE FURNACE TO OVERFIRE.**

Set temperature control to 150°F., and input controls to 50%, turn controls on, and watch to make sure the furnace fires no higher than 150°F. in either zone. Keep at 150°F. for 1 hour.

After first hour, raise temperature to 200°F. for 1 hour. Then raise to 250°F. and soak there for 6 hours.

Raise the furnace up to 1000°F. at 50°F. per hour. Soak at 1000°F. for 6 hours.

After the drying period, continue firing at a rate of 75°F. per hour up to the maximum temperature at which you will be using the furnace.

Allow the furnace to cool, with power off, down to room temperature with the door closed.

****

CRITICAL NOTE: It is absolutely critical that the first firing of the furnace be done no faster than this prescribed cycle. The water in the firebrick and cement must be driven off slowly. Otherwise the steam that will be created will cause cracks and extensive damage in the firebrick lining. L&L Special Furnace Co.,Inc. does not cover this sort of damage in the warranty.

****

GENERAL INFORMATION CONCERNING FURNACE OPTIONS

Furnaces may be ordered with many different types of options. If any options are included with this unit, instructions for operating the furnace with them are included in this section.

Some options are available which may be purchased later after the furnace has been installed. These would require installation by the customer; skilled installation assistance is available from L&L Special Furnace Co.,Inc., on a per diem basis. Contact the factory for more information.

Some of these options include:

CONTROL OPTIONS

* West Model 2050 Program Control
  (This can be directly substituted for the West 2070)
  (NOTE: It would be difficult to substitute the Honeywell 511 program control because of the larger panel opening required.)

* Overtemperature Control and Safety Contactors
  (All panel cutouts and contactor plate holes are already in place. Some careful rewiring is necessary.)

* Temperature Recorders
  (Several types are available. These can be supplied in a separate control panel with their own power supply.)

* Type K Flexible Thermocouple (Direct Substitution.)
* Type K Thermocouple with Alloy Protection Tube
  (This is an easy substitution.)
* Type R Thermocouple
  (NOTE: The West 2070 and the West 2050 controls can be converted from type K to type R by the factory. Check with factory concerning other controls' convertibility.)

HIGH UNIFORMITY OPTIONS

* Turboconvection Fan System (Limits temperature to 1875°F.)
  (This requires drilling a hole in the roof and some rewiring.)
* Recirculation Muffle (1400°F. or 1875°F.)
  (This is easy to install. It will reduce the inside dimensions and upper temperature limit of the furnace.)

ATMOSPHERE OPTIONS

* Venturis: Air Operated and Motor Driven
  (The air operated venturi is very easy to install; the motorized one takes some wiring and carefully cutting of the case.)
* Inert Atmosphere Sealed Case with Flowmeter/Regulator
  (NOTE: A kit to retrofit just the woven ceramic fiber door seal onto the furnace is also available. This can be helpful in preventing door seal damage and in increasing uniformity within the furnace.)

GENERAL INFORMATION CONCERNING FURNACE OPTIONS

HEARTH OPTIONS

* Silicon Carbide Hearth
* 330 Alloy or 235 MA Alloy Hearth
* Stainless Steel Hearth
  (All these hearth plates are easy to install. If you wish to cement in brick hearth supports like the factory normally supplies with these hearth plates it is fairly easy and drawings will be supplied.)
* Piers for Forklift Loading (Can Use Seal Bricks with Cement)
  (Normally when this is done by the factory a special bottom firebrick is made with special element spacing on the bottom. It would be very difficult to provide such a special bottom.)

DOOR, QUENCH TANK, AND MISCELLANEOUS OPTIONS

* Peephole Assembly
  (Requires some hole saw drilling.)
* Quench Tank with Drain and Casters
* Quench Tank with Drain, Forced Agitation, and Cooling Coil
* Stand for Bench Models
* Counterbalanced Vertical Door
* Pneumatic Operator for Vertical Door
  (Note: Either of these two vertical door options would require skilled assistance from L&L.)

See the INDEX/FURNACE DESCRIPTION section for complete descriptions of these options.

GENERAL THEORY OF OPERATION AND CONSTRUCTION (XLG GAS FIRED)

Your L&L Special Furnace Co.,Inc., furnace is a high temperature gas fired box furnace. The gas firing system consists of a complete gas train designed to NFPA standards for flame safety. The burner is an Eclipse Minimatic 50MMB burner. A bypass pilot system is used to maintain ignition after light up. An ignition transformer and spark plug are used to start the burner. See the gas flow diagram for specific information on how the system is piped. Note that there are two redundant solenoids for the main gas flow. Various interlocks prevent flow of gas under differing conditions.

The furnace is mostly insulated with 2300°F ceramic fiber Pyroblock modules which are 6" thick. The bottom is insulated with various layers of low density castable (on top), insulating firebrick and back up calcium silicate. This provides a lightweight but strong hearth insulation base for the work.

The control system consists of several components. Typically, a Honeywell UDC 3000 or other brand of temperature control controls the furnace temperature, and a Honeywell UDC 2000 or other brand overtemperature control protects against an overtemperature condition. Optionally available are program controllers to control temperature rise. The thermocouples for the temperature control and the overtemperature control are Type K. The thermocouples are usually located inside the chamber near the center, with the overtemperature thermocouple located closer to the top, hotter portion of the chamber. The two controls will read at different temperatures. You can set the overtemperature control at 2100°F.

The control feeds a 4-20 milliamp signal to an Eclipse Series EMP-3 Medium Torque Actuator. The actuator rotates in proportion to the signal of the control and provides true proportioning control. The actuator turns a damper for both the gas and the combustion air. Note that the combustion air is never turned completely off. This percentage of output is "tuned" by means of the Proportional Band (Gain), Rate, and Reset, adjustments in the controller circuit.The actuator motor is filled with oil for lubrication and cooling. Typically this does not need to be changed. See actuator instructions (Eclipse I-325 Info of 12/91) for more detail. The actuator takes about 6 seconds to drive in either full direction.

Also optionally available are several types of temperature recorders, normally supplied with a separate thermocouple. Most furnaces are additionally equipped with an overtemperature protection control with safety back up contactors. All controls and control components are normally mounted in one removable control panel which is specially made for the exact configuration of options that you have ordered.

OPERATION OF THE CONTROL PANEL

OPERATION OF THE CONTROL PANEL FOR XLG GAS-FIRED FURNACES

OPERATION OF THE ON/OFF SWITCH: To activate furnace, turn on main power at the fused disconnect switch and then push the On/Off switch. This is an oiltight, maintained contact push button type switch which has an internal pilot light to indicate "ON." When the switch is turned on, the pilot light lights, and the control circuit is activated. Pushing the switch again turns off the control circuit and the pilot light.

When the On/Off switch is started, and if the appropriate pressure switches are closed, the internal purge timer (on the Flame Safety module) starts timing out. The Purge Timer pilot light lights and remains lit until the Purge Timer times out.

OPERATION OF THE BURNER/ALARM SELECTOR SWITCH: Turn this to "ON" after the Purge Timer pilot light goes off. This acts as an interlock in the flame safety system and starts the pilot gas solenoid valve.

When Shutting the furnace down, turn this switch to off - but keep the main on/off switch on to allow the combustion blower to cool the burner block down.

OPERATION OF THE START BURNER SWITCH: When the Purge Cycle is complete, and the furnace is ready to start heating, press the Start Burner pushbutton and hold for several seconds. When the pilot flame is established, the Pilot On pilot light turns on. With the flame safety system satisfied, the main burner solenoid valves open and the gas burner fires at the rate called for by the temperature control.

OPERATION OF THE DOOR LIMIT SWITCH: All floor-model furnaces in the XLG Series are equipped with a door cut off switch. This cuts off power to the main gas solenoid valve, turning the burner to low fire when the door is opened. When the door is closed, a time delay relay prevents the main gas solenoid vlave from opening for a short interval to allow the chamber pressure to stabilize.

CAUTION: THESE CUT OFF SWITCHES ARE INSTALLED FOR YOUR PROTECTION.DO NOT DEFEAT THE PUROPOSE OF THESE IMPORTANT SAFETY DEVICES BYDISCONNECTING THEM!

HONEYWELL UDC 5000 TEMPERATURE CONTROLLER OPERATION

<u>IMPORTANT:</u> This L&L Special Furnace Co.,Inc., furnace is equipped with the Honeywell UDC UDC 5000 Temperature Control described below. Many are also equipped with an Overtemperature Control system. It is the user's responsibility to read and understand the control manufacturer's instructions. <u>Be sure to fill out any control warranty cards and send back to the control manfacturer.</u>

> <u>NOTE</u>: The user must monitor the furnace and controls for failure. L&L Special Furnace Co.,Inc., assumes no responsibility for any losses or damages caused by the malfunction of temperature controls. <u>We strongly recommend the use of a separate safety control with high temperature equipment.</u> As we understand the regulations, this is also an OSHA requirement. All L&L Special Furnace Co.,Inc., Furnaces manufactured after March, 1983, can be easily retrofitted with an Overtemperature protection system. Contact factory for further information.

<u>OPERATION OF THE HONEYWELL UDC 5000 RAMP/SOAK PROGRAM CONTROL</u>

Each application is different, and requires slightly different configuration. All of the configuration is done at L&L before shipping. If ever needed, re-configuration is straight-forward as described in the Honeywell manual. Our trained service representatives will be happy to assist.

A Configuration Sheet has been included with the testing documents in the Wiring Diagram section of the instruction manual. This shows how the Honeywell UDC 5000 has been configured at L&L.

Reading the Honeywell Operating Manual provides the most detailed operating instructions of the instrument; the purpose of this write-up is to point out some of the most important features of the instrument as they relate to the operation of the furnace.

Normally the instrument displays the temperature measured on the thermocouple selected with the thermocouple selector switch on the top display, and the lower display shows the current setpoint. Additionally there are indicators for which output is active, whether controller is in Manual or Automatic mode, etc. A deviation scale is located below the lower display which can show either 0-100% output, or +/-10% Deviation.

HONEYWELL UDC 5000 TEMPERATURE CONTROLLER OPERATION

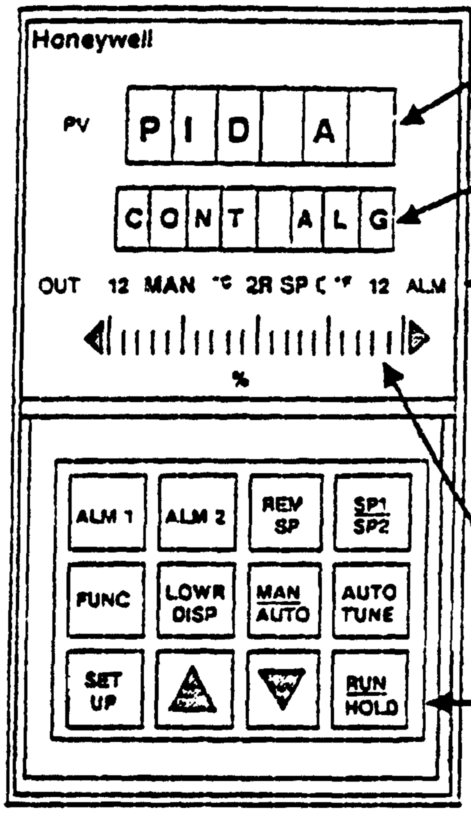
The function of the instrument is to cycle furnace temperature according to the heating Setpoint Program entered into the instrument. The PID (Tuning) constants are approximate only and will have to be changed by the user to suit load and furnace conditions. To adjust any offset of the measured temperature from the setpoint, tuning parameters can be adjusted. See the Honeywell manual.

When power is first turned on, the instrument performs a power-up sequence. The display cycles through RAM, Configuration, and Calibration tests, then all indicators are lit for a short time. At the end of the power-up sequence, the control goes into either the Manual, Automatic-Local Setpoint, or Automatic-Remote Setpoint - depending on configuration choices.

See the following page, copied from the Honeywell Product Manual, for a simple description of all the keys and displays.

OPERATOR INTERFACE OVERVIEW

2/89



***Upper Display** - six characters*
- Normal Operation - *displays the process variable*
- Configuration Mode - *displays parameter value or selection*

***Lower Display** - eight characters*
- Normal Operation - *displays operating parameters and values*
- Configuration Mode - *displays function groups and parameters*

Indicators

***OUT 12** = control relay 1 or 2 ON or Loop 1 or Loop 2 displayed*
***MAN(A)** = indicates controller mode (manual or automatic)*
***°C** = degrees celsius being displayed*
***2RSPC** = those lit indicate the set point being used*
- SP — 1st local set point
- 2SP — 2nd local set point
- RSP — Remote set point or 3rd set point
- C — computer set point

***°F** = degrees fahrenheit being displayed*
***12 ALM** = Alarm condition exists on alarm 1 or 2*

***21 Segment Bargraph** - displays either 0-100% Output or ±10% Deviation*

Key Functions (See Below)
Twelve keys enable complete configuration and operation.

ALM 1	lets you display and change ALARM 1 parameters without going into Set-Up mode.
ALM 2	lets you display and change ALARM 2 parameters without going into Set-Up mode.
REM SP	toggles between local set point and remote set point or local set point 3.
SP1 SP2	toggles between local set point #1 and #2
FUNC	• used in conjunction with [SET UP] key to select the individual functions of a selected configuration group. • Also used as *Loop Select Key* for 2Loop or cascade control
LOWR DISP	• scrolls through the operating parameters for viewing in the lower display. • Exits Set-Up mode
MAN AUTO	alternately selects control mode AUTO-set point indicated in lower display MANUAL-Output indicated in lower display
AUTO TUNE	• starts the Auto Tune procedure. • initiates short tune.
SET UP	places the controller in configuration group select mode. Sequentially displays configuration groups and allows the [FUNC] key to display individual functions for each group.
▲	increases the selected parameter value.
▼	decreases the selected parameter value
RUN HOLD	• initiates RUN or HOLD of the Set Point Ramp or Program • restores original parameter value during configuration

Figure 4-1 Operator Interface Overview

HONEYWELL UDC 5000 TEMPERATURE CONTROLLER OPERATION

To monitor the controller, use the keys as described below.

LOWER DISPLAY: The Lower Display Key can be used to select different parameters to be shown in the lower display. These are:

"OUT"	Percent Output
"2OT"	Output #2 (If 2 Loops are available)
"S P"	Local Set Point #1
"2SP"	Local Set Point #2
"RSP"	Remote Set Point (If available)
"1IN"	Input #1
"2IN"	Input #2 (For 2 Input applications such as Carbon)
"3IN"	Input #3 (If available)
"CSP"	Computer Set Point
"DEV"	Deviation from setpoint is degrees
"PIDSET X"	Tuning Parameter Set
"2PIDSET X"	Tuning Parameter Set 2
"xxRAHH.MM"	Time remaining in Setpoint Ramp segment
"xxSKHH.MM"	Time remaining in Soak Segment
"RECYC X"	Recycles left in Ramp/Soak program run
"RAMPXXXM"	Time remaining in single set point ramp.
"SAM"	Current Sample number for Autotune.
"1PV or 2PV"	Process Variable for Lopp 1 or Loop 2.

MANUAL/AUTOMATIC KEY: Alternately selects manual or automatic operation.

UP/DOWN KEYS: Increases or decreases setpoint, output, or configuration values. To change values quickly, while holding either the UP or DOWN key, press the other. The display will shift to the next highest digit.

AUTOTUNE KEY: Starts Autotune procedure. "KEY ERROR" is displayed if this feature is either not available, or disabled during configuration. This feature is not available unless by special order.

RUN/HOLD KEY:

Set Point Program: Used to alternately cause the set point program to run, or to hold.

Restore Value: Used to restore the originally displayed value when using the FUNC and UP/DOWN keys to change a parameter.

Note: If KEY ERR is displayed after a key is pressed, either:
- the parameter is not available
- the control is not in SETUP mode
- or the key is malfunctioning.

See the Honeywell Manual, Operation section, and perform a keyboard test.

HONEYWELL UDC 5000 TEMPERATURE CONTROLLER OPERATION

<u>MODES:</u>

The following operating modes are the normal modes avalable on most controllers supplied on L&L furnaces. They are accessed with the MAN/AUTO key.

<u>MANUAL:</u> The controller holds its output at the last value. The output can be directly altered with the UP/DOWN keys.

<u>AUTOMATIC (LOCAL):</u> The controller is controlling output at the local setpoint.

<u>AUTOMATIC (REMOTE):</u> The controller is controlling output at the "remote" setpoint received at Input 2.

See the Honeywell manual for further instructions on the use of the controller and all its features.

TYPE K CHROMEL/ALUMEL THERMOCOUPLES WITH PROTECTION TUBES

The thermocouples included with this furnace are Chromel/Alumel Type K thermocouples with alloy protection tubes.

Furnace operating conditions can seriously affect the performance of type K thermocouples. These optional Type K thermocouples with alloy protection tubes help protect the thermocouple elements from severe conditions which can affect the performance or life of exposed type thermocouple.

HOW LONG WILL A THERMOCOUPLE LAST? A variety of factors determine this. See the trouble shooting guide in the MAINTENANCE/TROUBLESHOOTING Section for specific problems. However, as a general rule, the following information, based on National Bureau of Standards tests in clean air on Chromel/Alumel 14 gauge thermocouples can serve as a guide.

When a type K chromel/alumel thermocouple ages it gradually loses its accuracy. It may have to be replaced before it actually breaks. A wise practice is to keep at least two thermocouples on hand for emergencies. At 1600°F. the thermocouple will drift - 5°F. in accuracy in 1000 hours. At 2200°F., the thermocouple will drift - 5°F. in 50 hours. At 2200°F., the thermocouple will drift 10°F. in 70 hours. At 2200°F., the thermocouple will drift - 25°F. in 175 hours.

THERMOCOUPLE POLARITY: Thermocouple polarity must be observed to insure proper readings. Moreover proper connections must be made throughout the circuit to promote accuracy. The thermocouple wire must directly touch the thermocouple lead wire unless there are special alloy lugs between the two (2) screws. The chromel alloy is marked CH while the alumel alloy is marked AL, if these lugs are used.

POLARITY CHART

	POSITIVE	NEGATIVE
Thermocouple wire alloy	Chromel	Alumel
Mark on thermocouple connector	+	-
Color of insulation on T.C. lead wire	Yellow	Red
Magnetism of wire alloy	Non-mag.	Magnetic

PREMATURE FAILURE: Premature thermocouple failure is almost invariably due to contamination or corrosion of the wires which in turn is caused by uncontrolled furnace atmosphere, unclean or leaking protection tubes, or some other factor related to improper installation or operation. Such premature failures are generally due to one of the following:

SULFUR ATTACK: Sulfur is particularly harmful to high nickel alloys, such as Alumel. In heat-treating operations, sulfur may come from oil, dirt, mortar, furnace cements, and some grades of asbestos, etc. On Chromel/Alumel thermocouples, sulfur attack manifests itself by causing breakage of the Alumel wire. Thus,

if normally ductile Alumel wire appears to be brittle-that is, if surface cracks appear when it is bent with the fingers-there is a good possibility that sulfur corrosion has occurred. In case of doubt, this can be determined positively by performing any one of several chemical tests.

A simple test for the presence of sulfur in a suspected material is to immerse a sample of the material into a solution of 20% hydrochloric acid containing a few pieces of metallic zinc. If sulfur is present on the sample, it can be identified by the characteristic hydrogen sulfide odor of rotten eggs that will evolve. Also, moistened lead acetate paper held over the top of the test solution will turn brown or black if sulfur is present on the sample.

"GREEN ROT CORROSION: "Green Rot" - so named because of the greenish scale that is often encountered in the corrosion of nickel-chromium alloys-is caused by a "partially" oxidizing atmosphere. The reducing gases may be present in the furnace itself, or they may occur in the protection tube as a result of oil, asbestos or carbonaceous matter in the tubes. Also, a corrosive atmosphere i.. the furnace may attack the thermocouple due to a leak in the protection tube or even by diffusion through the tube wall if various protective atmospheres are used. Regardless of origin, however, it is characteristic that such a contaminating condition will effect Chromel to a much greater extent than Alumel. When "green rot" corrosion has occurred, the non-magnetic Chromel wire will become magnetic and it may also acquire a mottled, silvery colored skin. Thus, whenever Chromel-P is found to be magnetic, chances are that it has been contaminated due to preferential oxidation which, in turn, would cause its emf calibration to be thrown off. It should be explained, however, that "green rot" is not caused by the reducing atmosphere itself. Instead, such corrosion is encountered when a small amount of oxygen, either from the atmosphere or the wire itself, is available. Under these conditions, the Chromel wire is subject to a change in emf because the chromium contained in the alloy is preferentially oxidized, leaving a metallic nickel skin. The effect of this combination is to reduce the "emf" (this is a measure of the electrical output of the the thermocouple.) To overcome such difficulties on thermocouple installations, the conditions which caused them will have to be corrected. In many instances, this may be accomplished simply by making sure that the protection tube used is clean when placed in service. In cases where the protection tube has a large diameter-to-length ratio, heating for one hour at 1500°F. is suggested. This treatment will burn off any foreign or organic matter which may be inside the protection tube and thus contribute to the dependable long-life service inherent in Chromel/Alumel thermocouple alloys.

HOW TO TUNE YOUR DIGITAL CONTROL TO ACHIEVE OPTIMUM RESULTS

Your furnace comes equipped with a digital temperature control with programmable P.I.D. Setting. For purposes of discussion, this instruction sheet will use the Honeywell UDC 3000 temperature control for an example. However, most other digital controls operate in a similar manner. Be careful to make sure that the control is set up with the tuning constants reading the way they are discussed in this instruction sheet because they can be set up as inverses which will cause much confusion and wasted time.

P.I.D. CONSTANTS

P.I.D. stands for 'proportional-integral-derivative.' P.I.D. tuning is common to many control situations where there is a feedback loop telling the output device (or heaters in the instance of a furnace) how much to output to reach and maintain a given value or set point. There is always a characteristic delay or lag built into the system caused by such factors as thermal mass, etc. Keep in mind the following simple information: PB or proportional band has the most effect on the overshoot or undershoot of the furnace. The larger the number, the longer the heat up. At a value of 0, the control becomes in effect an on/off control. It would not "proportion" at all around set point but would rather wait until the furnace reached set point and then completely turn off until the furnace was below set point. The proportioning band is essentially a figure representing a percentage of set point around which the control "proportions" the amount of power going to the furnace. (NOTE: The UDC 3000 can be configured to have this setting as "gain" which is the inverse of PB. We suggest keeping it set as PB.) The Integral or Reset has the most effect on cycling or stability of the system. It shifts the power output level as a result of the error between the measured value and set point. Basically it is "resetting" the power level. The faster the Reset the less information it is using to make its correction but the more "responsive" it is to changes. The slower it is the more "correct" its power setting is because it is using more information to make its decision. In the UDC 3000 control this is expressed as either Reset in "Minutes per Repeat" or Reset in "Repeats per Minute." Set the control up for Reset in "Minutes per Repeat". (This is set up under CONTROL/MIN OR RPM). The smaller this number in Minutes per Repeat, the faster the power will shift in response to a change. A setting of 0.02 (the smallest setting in the UDC 3000) will definitely cause oscillation because the control is working faster than the system can accept it. Derivative action or Rate provides a sudden shift in output as a result of a quick change in measured value (for instance when a set point is changed). In the UDC 3000 this is expressed as a Rate in Minutes. It is also related to time but has a much lesser effect on the system response.

PURPOSE OF TUNING THE CONTROL

The P.I.D. settings allow the control to be "tuned" for optimum results. In most batch furnace applications this "optimum result" is the best balance between fast heat up and little or no overshoot past the set point. The idea is to anticipate set point temperature before getting there and gradually slow down heater output so that the furnace doesn't overshoot the set point because of system inertia. Some processes are more critical in terms of allowing for some overshoot. In fact, the "optimum result" is something that must be determined by the user.

HOW TO TUNE YOUR DIGITAL CONTROL TO ACHIEVE OPTIMUM RESULTS

THE FURNACE AND LOAD

Each heating condition is different. It depends on the load, the temperature, the characteristics of the furnace, elements, air circulation, etc. That is why no standard P.I.D. tuning constants can be given which will work in all or most situations. It is possible to tune a furnace with no load or from deep inside a load or retort. Each situation will have its own characteristic lag time or responsiveness built into it.

SIMPLIFIED METHOD OF TUNING

1) Hook up a recorder, if you have one, to continuously record furnace temperature. If you can scale the recorder, scale it with a small scale of about 100° to 200° around set point. If you don't have a recorder, use graph paper to record time vs temperature. Wait until the furnace is cycling before making up a graph (that way you will know what kinds of temperature extremes and time periods to make on the graph).

2) Set the PB to 2.0. (Try 3.0 or 1.0 if this doesn't work as described at first.) Set the Reset (in Minutes per Reset) to 0.02 (or 0.00 if you have a control that allows that). Set the Derivative to 0.0. Set the set point to any temperature setting that is at least 50°F to 100°F above whatever temperature the furnace is at, with a minimum of about 500°F.

3) Let the furnace cycle."Cycling" means that the temperature is rising and falling in a predictable sine wave pattern. IT WILL PROBABLY NOT CYCLE AROUND THE SET POINT. An offset from set point is not relevant at this time. We are merely looking for the characteristics of the cycle time. Record the cycle. Note that the cycle may be anywhere from a few seconds to many minutes. It will repeat itself fairly consistently. Two or three cycles are enough to get good data. This time cycle will be a "snapshot" or insight into the time delay built into the system.

4) Once you have a characteristic time cycle measure this in terms of minutes.

   a) If you want the furnace to be responsive and you don't care about slight overshoot then enter the time you have measured (say, for instance, 11.5 minutes) as your Reset value. Multiply the time value times 1/6 or .167 and enter this value as your Rate.

   b) If you want to have a very responsive system and some overshoot and some cycling is O.K. before the furnace settles down to set point then the Reset value shout be .5 (1/2) times the measured time value (.5 x 11.5 = 5.75 in the above example) and the Rate should be 1/8 or .125 times the measured value (.125 x 11.5 = 1.43 Minutes in the above example.

c) If you want to prevent overshoot totally multiply the measured value times 1.5 (in the aboe axample 11.5 x 1.5 = 18/25 Minutes per Repeat) and enter this value as your Reset value. The Rate value stays the same (.125 x the measured time cycle) for such a critically damped tuning.

5) Raise the set point by 50 to 75°F and record the rise. With the Reset and Rate values entered properly you should notice that oscillation has been removed or minimized (depending on your preference). from the system. <u>You have adjusted the time based tuning constants to match the characteristic lag of the system.</u> If the furnace does not reach set point the PB is too great and must be lowered. If it overshoots and stabilizes above set point the PB is too small and must be raised. Raise or lower the PB in 1 or .5 increments (raising the furnace set point 50 to 75°F each time) until the curve is exactly the way you want it and the system maintains set point.

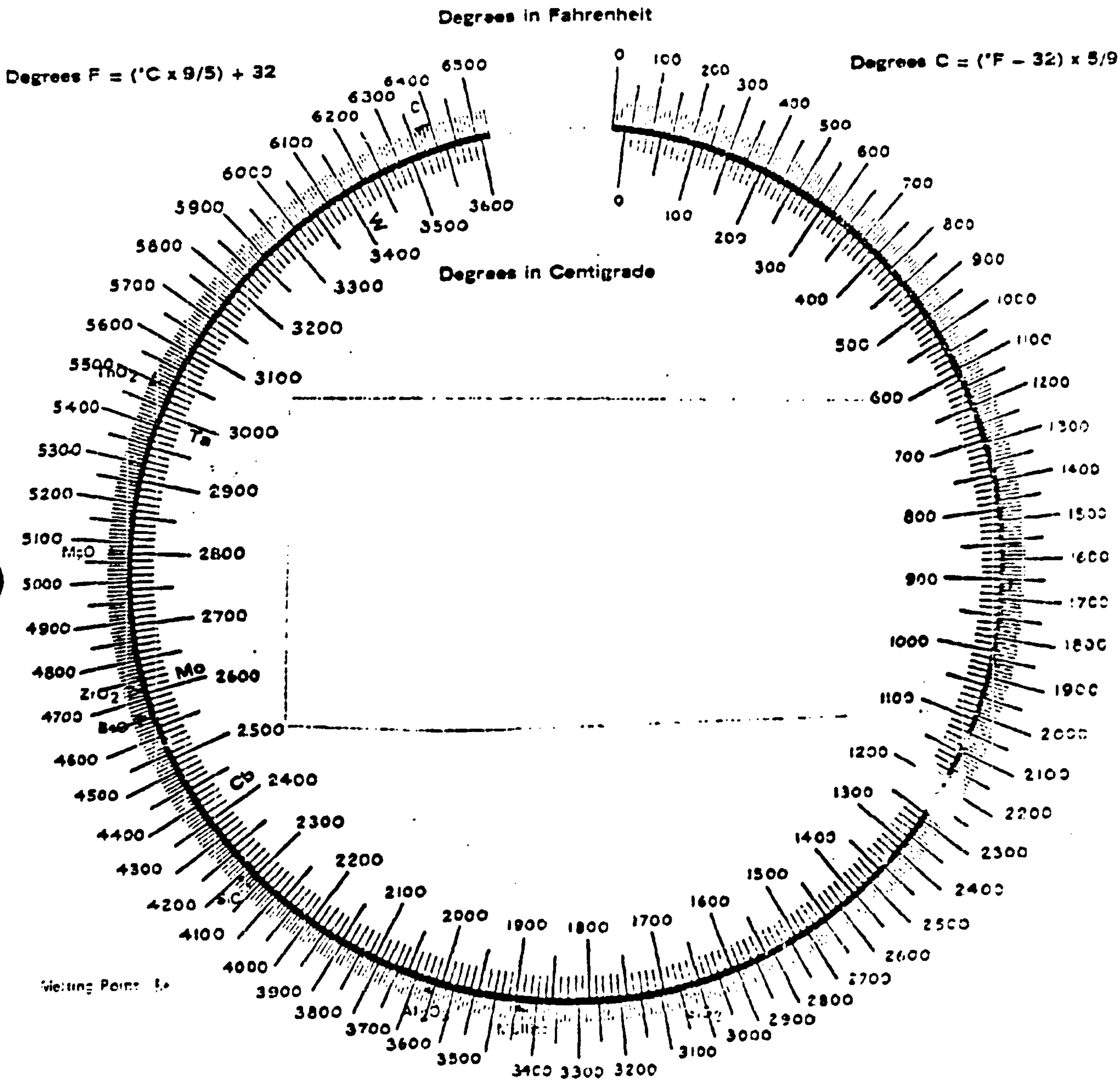
6) Note that on time proportioning systems (contactors vs fully proportioning power controls like SCRs) there is a further adjustment of Cycle Time. This is the amount of time the contactor stays on or off when the control tells it to proportion. The faster the cycle time the more "tunable" the system will be. The downside to fast cycle time is short contactor life. With mercury contactors we recommend a Cycle Time of 2 or 4 seconds. With time proportioning systems there may always be some cycling. With completely proportional systems it is possible to eliminate all cycling.

CHANGING P.I.D. CONSTANTS

The Honeywell UDC 3000 control can have two sets of P.I.D. constants which can be switched easily. This allows you to tune the instruments for two critical temperatures or load sizes (i.e. two different sets of conditions). The P.I.D. settings can be toggled manually or changed automatically based on a process variable or a set point. Therefore you could easily have two different sets of P.I.D. settings come into play at different temperatures. This can be used, for instance, to have a fast approach to a particular temperature and then have critically damped P.I.D. constants as the furnace approached a critical temperature.

TEMPERATURE CONVERSIONS

The following information is included to assist the customer in making temperature conversions between degrees Centigrade and degrees Fahrenheit.



OPERATION OF THE HONEYWELL UDC3000 OVERTEMPERATURE CONTROL

As L&L Special Furnace Co.,Inc., interprets the regulations, OSHA requires a separate manually resettable temperature controller with back-up power switching devices to act as a high limit shut- off in case of excess temperature condition.

OPERATION OF THE HONFYWELL UDC 3000 OVERTEMPERATURE CONTROL

To set temperature press LWR DISP key and use the UP/DOWN keys to display desired setpoint. The display flashes "LIMIT" to indicate that the relay is de-energized; push the RESET key to energize the relay and allow the furnace to heat. The display stops flashing "LIMIT."

If the furnace temperature exceeds the setpoint, the relay is de-energized and the furnace is shut off. The display flashes "LIMIT to indicate an overtemperature condition. Some furnaces are equipped with a buzzer to alert the user.

OPERATION OF THE OPTIONAL DPR-4500 ROUND CHART RECORDER

Your furnace is equipped with a **Honeywell DPR-4500** Series Round Chart Temperature Recorder for keeping accurate records of the process temperature in the furnace. These are supplied in various configurations to suit specific requirements. A separate thermocouple is normally supplied with the temperature recorder. However, it is possible to use the thermocouple of the control by using a parallel circuit. (Contact factory for more information on this if ever necessary.)

Install the chart and check the ink cartridge on the instrument according to the Honeywell Control Instructions. Index to the desired location. Start the recorder by turning on the control system on/off switch. The recorder makes a record of the time versus temperature curve which the furnace has actually followed.

Most **Honeywell DPR-4500** instruments used on L&L furnaces are single pen recorders. For the two-pen models used on certain QD dual chamber units, two ink cartridges are used on separate pen arms. Check both ink cartridges before each run to avoid problems.

L&L does not stock Honeywell charts and ink cartridges. These must be ordered from the Honeywell sales office nearest the user. L&L recommends that the user keep a stock of supplies to avoid interruptions.

ROUTINE FURNACE MAINTENANCE

DISCONNECT ALL POWER TO THE FURNACE WHEN PERFORMING ANY MAINTENANCE PROCEDURE REQUIRING ACCESS TO THE FURNACE CHAMBER OR ELEMENT CONNECTIONS. TEST WITH A VOLTMETER TO BE CERTAIN POWER IS IN FACT DISCONNECTED.

ROUTINE MAINTENANCE: Several routine maintenance procedures are recommended to keep the furnace in its best operating condition.

1) Every 50 hours of operation vacuum out the furnace interior. Do this more if your process generates a lot of scale or dust. Metallic scale from oxidation of work can cause short circuits in the bottom elements.

2) If you have Type K thermocouples check them for excessive oxidation every 100 hours of operation. Replace when they become severely oxidized. Do not wait for breakdown - keep a set on hand. See thermocouple information (E.4) in the Operation section of the Instructions Book.

3) Inspect the firebrick lining every 100 hours of operation. Patch any cracks or chips with L&L refractory cement. Make sure the door seal is kept adjusted tight. Inspect all element holders for looseness. A little looseness is OK but if there is any chance that the holder could come loose pin it in with nichrome pins (available from L&L Special Furnace Co.,Inc.) and/or cement the holders in. Inspect element condition.

4) If you have a ceramic fiber roof check it every 100 hours of operation for any shrinkage that might have taken place. Look for any openings and stuff with pieces of ceramic fiber blanket.

5) Refer to the Maintenance Procedures for any options that may be included with the furnace. Certain accessories such as fans require periodic checking and lubrication for optimum performance.

6) Tighten all pivot bolts on the Door Hinge every week. These can work loose, possibly leading to the door falling out of the hinge and consequent injury to the operator.

SERVICING OF THE CONTROL SYSTEM

CONTROL SERVICING: Control instruments must be serviced by the control manufacturer. L&L Special Furnace Co.,Inc., can assist with obtaining this service if necessary. Also L&L Special Furnace Co.,Inc., offers control rental on certain in-stock instruments. Contact factory for more information.

Telephone numbers for some control manufacturers are:

Barber Colman:	(309) 788-1275
Halmar:	(614) 275-0530
Honeywell, Inc.:	(215) 666-8200
Leeds & Northrup:	(215) 441-5600
Research, Inc.:	(412) 941-3300
Watlow:	(507) 454-5300
West:	(401) 884-6800

Some of these numbers are the direct number for service and some are the number where you can find out who does the local service in your area.

REMOVABLE CONTROL PANEL: Occasionally a problem comes up that is not easily solved in the field. In these cases the design of the removable control panels on all units serves a major function. The whole control panel can be shipped to the factory for expert evaluation. No travel time by the factory is involved, which can save expenses. Air shipment is recommended for expedited service. Be sure to pack with lots of cushioning and make packing easily reusable by L&L Special Furnace Co.,Inc.

FACTORY SERVICE: The services of a skilled electrician are available from L&L Special Furnace Co.,Inc. on a per diem basis. See the PARTS ORDERING Section for more information or call the factory. If the problem is internal to a control component there is normally nothing that our factory technician can do and the problem must be resolved by the control manufacturer.

RECORDER SUPPLIES: L&L Special Furnace Co.,Inc., does not stock recorder charts, pens or ink. Contact control manufacturer directly. The above numbers given will help.

PLACES TO DISPOSE OF MERCURY CONTACTORS IF EVER NECESSARY

Mercury distillers and retorters (United States, as of September) 1993

COMPANY	STARTUP DATE	FEEDSTOCK	EQUIPMENT	ESTIMATE OF 1992 THROUGHPUT, (Lb. Hg)
Adrow Chemical Wanque, NJ	1960	Flowable 99%-Hg; no Th,Ga,Pb,Cd,As,Li	Distillation	50,000
D.F. Goldsmith Chemical and Metal Evanston, IL	1960	Flowable 99%+Hg; no Th or Ga	Distillation, including NaOH and HNO3 washing	200.000
Quicksilver Recycling Brisbane, CA	1985	Flowable 99%+,or solids contaminated with metallic Hg; no Cl, acids or bases	Physical separation (hand sort, crush/shred/filter); distillation	100,000 RCRA Part B-TSD
Bethlehem Apparatus Hellertown, PA	1955	Solids>5%Hg, and <40%H2O; no solutions, Cl, Li, As, organo Hg, acid, alkali, water treatment sludge, or P-code	Eleven batch retorts (six more being installed); distillation	300,000 Applied for "Permit by Rule" from Pennsylvania
[illegible]y Refining [illegible] Colonie, NY	1955	Battery manuf. Waste; batteries containing Hg fluorescent and Hg lamps; lamp phosphors; Hg in glass and metal devices; soils, some compounds, solutions and sludges; Cl <0.1%; No P-, K- or F-code wates	Two retorts, to be replaced by four retorts (batch) to handle materials up to 10' x 20" x 20" in new facility; distillation, including HNO3 washing	220,000 Part 373 (NY) pending
NSSI/Recovery Services Houston, TX	1971	Metallics, organo-Hg, phosphor, batteries, sludges, radioactives, chemicals; no fulminates	Leaching, neutralization, SX, LX, EW, thermal treatment, and two batch retorts (55 gallon)	1,000 RCRA Part B-TSD

HOW TO REPAIR FIREBRICK

IMPORTANT: CURING CYCLE AFTER BRICK REPAIR OR REPLACEMENT: After brick has been repaired or replaced, it is necessary to put the furnace through a curing cycle similar to the First Firing and Curing Cycle in the INSTALLATION Section of the Instructions Book. Follow the instructions in that section for this cycle. **Failure to follow this procedure will result in probable failure of the repair.**

REPAIRING FIREBRICK:

NOTE: L&L Cement is available in 1/2 pints, pints, quarts and gallons. See the PARTS LIST/ORDERING Section for more information. Grout can be ordered from L&L in the same quantities or can be made by mixing 50% cement and 50% brick dust.

SMALL CRACKS AND HOLES: These can be repaired by filling with grout.

1) Vacuum out all loose fragments & dust. Get the firebrick surface as clean as possible.

2) Wet the surface to be repaired and the area for approximately 2" around it. Try to have the water absorb into the firebrick at least 1/2" deep. (This allows time for the grout to set up. Otherwise, the brick would absorb moisture from grout too quickly.) A paint brush is a handy tool to do this wetting.

3) Mix grout - approximately 50/50 standard L&L Special Furnace Co.,Inc., brick cement and brick dust. The ratio will differ depending on consistency of the cement. Mix together until it is the consistency of dough.

4) Jam as much grout in as possible. Try to get the grout to go in as deeply as possible. Use a puddy knife or a broad bladed screw driver to force the grout in.

5) Use the puddy knife to resurface and smooth out the grout. Grout should be finished off so no rubbing is necessary.

LARGER HOLES & BRUISES: In these cases a section of brick will have to be cut out and a plug put in. The minimum size of a plug is 1-1/4" square. Smaller than 1-1/4" square will increase chance of rebreakage.

1) Cut out area, a minimum of 1-1/4" square, around area to be repaired. The cut should be made with flat surfaces. Use a broad bladed screw driver or small chisal (carefully) and smooth out surfaces with a stiff puddy knife.

2) Vacuum out all loose brick. Clean as much as possible.

REPLACING INSULATION FOR FM FURNACES

IMPORTANT: CURING CYCLE AFTER BRICK/CASTABLE REPAIR OR REPLACEMENT: After brick or castable has been repaired or replaced, it is necessary to put the furnace through a curing cycle similar to the First Firing and Curing Cycle in the INSTALLATION Section of the Instructions Book. Follow the instructions in that section for this cycle. Failure to follow this procedure will result in probable failure of the repair - or, even more seriously in the case of castable, possible furnace interior damage should the castable reach a critical temperature without being dried out.

REPLACING HEARTH CASTABLE AND INSULATING FIREBRICK

NOTE: Castable and firebrick sections can be ordered from the factory. Castable sections are cast in molds. Firebrick cementing is done on an extremely flat table and then the sections are cut to precise specifications. Delivery can take three to four weeks for some sections. Because of this it is wise to anticipate needs and order ahead of time. You will normally know well ahead of time that your hearth sections need replacing. Often emergency repairs can be performed that will prolong the furnace lining at least as long as it takes to get the sections. L&L does not recommend or endorse repairing the furnace lining in any other way than is mentioned in these instructions.

NOTE: Factory service is available to either perform this maintenance work on your premesis or to have your furnace sent back to L&L. Contact the factory for more information and/or look in the PARTS LIST/ORDERING Section.

1) Disconnect all power from the furnace. Check with Voltmeter to be certain.

2) Remove the old sections that are to be replaced.

3) Install the new sections. Some fitting may have to be done: rubbing the edges of the sections down to fit into place can be done with a coarse firebrick or sandpaper wrapped around a board.

IMPORTANT NOTE: All the sections should fit snuggly together and, above all, there should be no gaps or holes that will let heat escape to the outside furnace wall. Actually, the firebrick sections are designed to have heat locks so that when they are layered together a small imperfection in the firebrick or a small gap will still not let much, if any, heat through.

REPAIR OF CERAMIC FIBER MODULES: All side, roof, door and back walls are insulated with ceramic fiber modules. These are made from strips of ceramic fiber blanket (6# density) which are mechanically held in place by stainless steel rods in sheet metal backed modules. The modules are 12" by 12" or less for easy handling. The modules are held in place by sheet metal screws. It is possible to remove the modules by unscrewing them from the outside of the case. They can be taken apart if necessary and new

ceramic fiber pieces put in place. Normally, this should not be necessary. If there is any shrinkage you can simply take pieces of ceramic fiber blanket and stuff it between the layers of ceramic fiber. In addition, if you wish, you can take nichrome pins and pin the fiber in place after stuffing it.

REPLACEMENT OF CERAMIC FIBER MODULES: Order the module from the factory by refering to your PARTS LIST. Remove the old module as stated above and put in a new one. You may find some ceramic fiber blanket stuffed inbetween where two modules meet. Replace this stuffing and be sure that it is tightly in place and will not fall out.

REPLACEMENT OR REPAIR OF CERAMIC FIBER SEALS: All door and case seals, and some special seals in certain FM furnace designs, are constructed of either ceramic fiber board, or ceramic fiber blanket wrapped in a protective alloy mesh. These are held in place mechanically with screws or nuts and bolts. Replacement is straightforward - simply remove the defective seal, and replace with a new one using the same fasteners and holes.

TROUBLE SHOOTING GUIDE FOR L&L FURNACES 1.1

__Please read this Guide BEFORE calling the factory.__ This is meant to help trace any problems that may occur during the life of an L&L Special Furnace Co.,Inc., furnace. Problems that can arise with any of the normally provided optional accessories are also mentioned.

The remedies described are listed in the recommended order of trial. Try Remedy A first, then B, etc. Detailed instructions for checking certain components are at the end of the Trouble Shooting Guide. These instructions are referenced as Notes throughout the Guide.

It is essential that a proper multimeter (ohm meter and voltmeter) be on hand for performing many of these tests. A clamp-on ammeter is also necessary for some tests. No particular brand is recommended; be sure to have a meter with the proper volt range for the supply voltage, and that the ohm meter has a 0 to 200 ohms range. L&L Special Furnace Co.,Inc., uses a Beckman 3000 meter.

CAUTION! Many of these tests require working with line voltage. Only an experienced electrician should perform these tests under these conditions.

LIST OF SYMPTOMS IN ORDER OF APPEARANCE

1) NO POWER AT ALL.
2) POWER ON, NO HEAT.
3) CONTROL INDICATES UPSCALE. NO HEAT.
4) CONTROL INDICATOR SEEMS TO READ IN REVERSE.
5) POWER ON, REDUCED HEAT.
6) PREMATURE ELEMENT BURN OUT.
7) CONTROL INDICATES ERRATICALLY.
8) FURNACE TEMPERATURE OVERSHOOTS SET POINT.
9) CHAMBER TEMPERATURE UNIFORMITY NOT UP TO STANDARDS.
10) OXIDATION IS OCCURRING EVEN WITH INERT ATMOSPHERE.
11) FAN DOES NOT ROTATE.
12) FAN SHAFT CAUSES EXCESSIVE SHAKING NOISE.
13) VENTURI IS NOT EVACUATING.
14) CONTACTORS CHATTER OR HUM.
15) EXCESSIVE BRICK WEAR.
16) CRACKED HEARTH.

SYMPTOM 1: NO POWER AT ALL.
REMEDIES:

A) Check to make sure power supply is per data nameplate.

B) Check pilot light operation. (Note 3)

C) Check fuses. (Note 1)

D) Check on/off switch operation with meter. (Note 4) E) Check for short circuits. (Note 2)

SYMPTOM 2: POWER ON. NO HEAT.
REMEDIES:

A) Check door and back element cover limit switches for proper operation. (Note 8)

B) Check fuses. (Note 1)

C) Check supply voltage to make sure it agrees with nameplate rating. (Note 15)

D) Check for short circuits. (Note 2)

E) Check power contactor coils. (Note 6)

F) Check input controls. (Note 5)

G) Check temperature controller for correct relay operation. (Note 7)

SYMPTOM 3: CONTROL INDICATES FULL UPSCALE. NO HEAT.
REMEDIES:

A) This indicates thermocouple circuit failure. Check thermocouple end.

B) Check thermocouple circuit. (Note 12)

SYMPTOM 4: CONTROL INDICATOR SEEMS TO READ IN REVERSE.
REMEDIES:

A) Check thermocouple polarity. (Note 13)

SYMPTOM 5: POWER ON. REDUCED HEAT.
REMEDIES:

A) Check supply voltage to make sure it agrees with nameplate rating. (Note 15)

B) Check fuses. (Note 1)

C) Check for short circuits. (Note 2)

D) Control may not be adjusted properly. (Note 11)

E) Check input controls. (Note 5)

F) Check power contactor coils. (Note 6)

G) Check element resistance values. (Note 9)

H) Check temperature controller indication against standard. (Note 10)

I) Check loading pattern. If load is too close to elements, reduce load so that 2/3 of chamber volume is utilized. This assures maximum uniformity as well as protecting elements.

J) Make sure hearth plate is not resting on element holders. Use ceramic standoffs to set hearth plate over elements. (See section on hearths in Installation Instructions.)

K) Element ends twisted too tightly, causing stress at terminal through holes. This causes local overheating at through hole, and element failure. (Contact factory.)

L) Door is not sealing against front correctly, and a red glow is visible around the door seal when furnace is operating. Also excessive heat loss can be felt around seal. Rub front seal high points down until no more than 1/16 of an inch gap is found at any point along seal. Or, a fiber tape retrofit kit is available to enhance the seal. Contact the factory.

M) Make sure all elements are heating. Operate furnace at a high enough temperature to see all elements glow and visually check each element to make sure it is operating. If not, check element resistance values and continuity. If any are open, replace them. If all are within standards, trace wiring for missing or bad connections.

SYMPTOM 6: PREMATURE ELEMENT BURN OUT.
REMEDIES:

A) Load too close to elements. Reduce load so that 2/3 of chamber volume is utilized. This assures maximum uniformity as well as protecting elements.

B) Make sure hearth plate is not resting on element holders. Use ceramic standoffs to set hearth plate over elements. (See section on hearths.)

C) Make sure element alloy is right for furnace atmosphere conditions. If unsure, consult factory - be sure to have atmosphere information. (What type of gas? Are any waxes, oils, fumes present?) See the section on Element Life and Limitations in the Operation Instructions.

D) Check bottom element holders for loose scale from the work pieces. Vacuum the holders regularly per Routine Maintenance section.

E) Check process for excessive carbon buildup in furnace chamber. If any carbon is present in process at all, be sure to operate the furnace WITHOUT A LOAD on a regular schedule to burn the carbon out. Do not run atmosphere during the burn out cycles. Suggested frequency of burn out cycles is once every three loads for light carbon build up, and once after every load for heavy carbon build up.

SYMPTOM 7: CONTROL INDICATES ERRATICALLY.
REMEDIES:

A) Check thermocouple for correct immersion depth. Welded end of probe should protrude at least 1-1/2" into chamber. See section on Thermocouples in the Operation Instructions.

B) Check thermocouple circuit. (Note 12)

C) Check supply voltage to make sure it agrees with nameplate rating. (Note 15)

D) Check transformer for proper primary jumper hook-up for input voltage. Check transformer output voltage and compare against control manufacturer voltage specification (Note 14)

E) Check temperature controller for correct relay operation. (Note 7)

F) Control is not adjusted properly. (Note 11)

G) Check temperature controller indication against standard. (Note 10)

H) Check contacts on power contactors. If fused together, replace contacts or complete contactor.

I) Check interior temperature of control panel (Note 16)

SYMPTOM 8: FURNACE TEMPERATURE OVERSHOOTS SET POINT.
REMEDIES:

A) Check thermocouple for correct immersion depth. Welded end of probe should protrude at least 1-1/2" into chamber. See section on Thermcouples in the Operation Instructions.

B) Check temperature controller for correct relay operation. (Note 7)

C) Control is not adjusted properly. (Note 11)

D) Turn down input switch settings. Try 75%, then 50%.

E) Try different settings of Maximum Power Output (On West 2070 Controller - see Control Settings in Operation Section.) Instead of 100%, try 75%, then 50%, etc.

F) Try faster cycle time on controller. If faster than 15 seconds, mercury contactors should be used. (These are standard for all models [except HB and QD 29] manufactured after October, 1984.) Retrofit kits are available from the factory to change over to mercury contactors.

G) Check contacts on power contactors. If fused together, replace contacts or complete contactor.

H) Check temperature controller indication against standard. (Note 10)

I) Check interior temperature of control panel. (Note 16)

J) If all else fails, call factory for information on selective disconnection of some elements.

SYMPTOM 9: CHAMBER TEMPERATURE UNIFORMITY NOT UP TO STANDARDS.
REMEDIES:

A) Adjust input switches. (Note 17)

B) Check thermocouple for correct immersion depth. Welded end of probe should protrude at least 1-1/2" into chamber. Read section on T.C.'s.

C) Load too close to elements. Reduce load so that 2/3 of chamber volume is utilized. This assures maximum uniformity as well as protecting elements.

D) Make sure hearth plate is not resting on element holders. Use ceramic standoffs to set hearth plate over elements. (See section on hearths.)

E) Check fan. (See "SYMPTOM 11: FAN DOES NOT ROTATE.")

F) Check RPM of fan motor. If not to nameplate rating, fan rotation will of necessity be reduced, reducing chamber uniformity. Check voltage and wire hook-up to motor. Repair or replace motor if necessary.

G) Check door seal gap. If door is not sealing against front correctly, a red glow is visible around the door seal when furnace is operating. Also excessive heat loss can be felt around seal. Rub front seal high points down until no more than 1/16 of an inch gap is found at any point along seal. Or, install a Fiber Seal Retofit Kit, available from the factory.

H) Make sure all elements are heating. Operate furnace at a high enough temperature to see all elements glow and visually check each element to make sure it is operating. If not, check element resistance values and continuity. If any are open, replace them. If all are within standards, trace wiring for missing or bad connections.

SYMPTOM 10: OXIDATION IS OCCURRING EVEN WITH INERT ATMOSPHERE.
REMEDIES:

A) Try different pressures Start low. For Bench Models with 7 LPM flowmeter, try 2 to 3 P.S.I. For Floor Models with 10 LPM flowmeter, try 5 P.S.I.

B) Try higher flow rates. 6 volume changes per hour is normal, and up to 10 changes per hour is not out of the ordinary. Check to make sure your flowmeter is providing this flow rate capability.

C) Try purging longer to remove air or oxygen from insulation.

D) Check gas inlet and outlet for blockage.

E) Check all seals visually. Pay attention to the fiber tape seal around the door. If worn, replace. Check all screws on case to see whether they have been untightened and not resealed. Reseal with high temperature silicone. Check all other areas where silicone has been applied.

F) Try running 80 P.S.I. compressed air when the furnace is cool, and check for blow-out at seals.

G) Try a gas mixture with some hydrogen or natural gas or propane. Be sure NEVER to use more than 4% combustible mixture. Industrial gas suppliers or welding gas suppliers will have recommendations.

H) Try putting in some steel wool to absorb excess oxygen.

I) In a worst case situation, a special top loading alloy muffle with self-contained inert atmosphere capability, which is loaded in and out of the furnace is available from L&L Special Furnace Co.,Inc. This, however, is not useful for parts that need to be quenched.

SYMPTOM 11: FAN DOES NOT ROTATE.
REMEDIES:

A) Check fan motor belts.

B) Check fuses. (Note 1)

C) Check motor starter or power relay to fan motor. (Note 6)

D) Check fan motor. Apply proper voltage directly to motor to see if motor is OK. Check voltage against wire hook-up to make sure power is hooked-up properly to motor.

E) Check bearings. If frozen, repair or replace.

F) Check to make sure fan blades are not hitting brick or muffle

SYMPTOM 12: FAN SHAFT CAUSES EXCESSIVE SHAKING NOISE.
REMEDIES:

A) Heat dissipator is loose. Raise 1/2" - 3/4" from furnace case and re-tighten to fan shaft.

B) Check fan shaft and motor pulleys for correct alignment. Adjust if necessary.

C) Fan shaft may be warped, or unbalanced. Consult factory.

SYMPTOM 13: VENTURI IS NOT EVACUATING.
REMEDIES:

A) Check for blockage. Adjust air operated type through entire range of adjustment to optimize.

B) Check air supply on air operated type. Check motor on motor driven type.

SYMPTOM 14: MECHANICAL CONTACTORS CHATTER OR HUM.
REMEDIES:

A) Check for dust on contacts - use 80 PSI compressed air to blow out contacts while manually opening and closing the contacts.

B) Check transformer for proper primary jumper hook-up for input voltage. Check transformer output voltage. (Note 14)

C) Check power contactor coils. (Note 6)

D) Check contacts on power contactors. If fused together, replace contacts or complete contactor.

E) If above checks do not solve problem, either replace contactors with direct replacement, or retrofit with mercury contactors to eliminate future problems. See Price List, or contact factory.

SYMPTOM 15: EXCESSIVE BRICK WEAR
REMEDIES:
REMEDIES:

A) Was Furnace cured according to First Firing and Curing Cycle? Check this procedure in Installation section. (Note 18)

B) For light to moderate spalling, re-coat the brick with the grey facing available from the factory. This procedure can allow the brick to remain operational.

C) If possible try cooling furnace before opening door. (Note 18)

D) Check with factory about fiber tape door seal, or possibly a ceramic fiber door. (Note 18)

E) Certain gasses react with the brick and can cause deterioration. Check with the factory for an analysis if any kind of gas is used in the furnace, or if the furnace is used for burn out operations.

SYMPTOM 16: CRACKED HEARTH
REMEDIES:

A) Check hearth loading chart in the Installation section and compare against actual load. If actual load is excessive, contact factory for optional hearths. (Note 19)

B) Make sure load is not dropped onto hearth, but is set down gently to avoid mechanical shock.

C) Add supports in more locations under hearth to help distribute the load more evenly.

D) Minimize door openings to prevent thermal shock to hearth. (Note 19)

E) Purchase a silicon carbide or alloy hearth plate. In many cases the cordierite hearth is just not shock resistant enough. (Note 19)

DETAILED INSTRUCTIONS FOR CHECKING COMPONENTS

The following notes are referenced throughout the Remedies. These are more detailed instructions for checking certain components, with, in some cases, references to other sections in the Instructions for further information.

NOTE 1: CHECKING FUSES
With power disconnected at main disconnect switch, check ohms across each fuse. This should read a closed circuit (0 ohms, or very small fraction.) A blown fuse will read a large number of ohms, or 'Overload', indicating that the circuit is open. Some ohm meters have a continuity tester; this tests for a closed circuit, and can be very helpful in diagnosing fuse conditions.

When checking fuses, also check that all fuses are the correct size. See wiring diagrams for this information.

If fuses are blowing erratically, a higher ampere fuse may be necessary. Check the surge amperes, which are the amperes that are developed when the main power is first turned on. Replace the fuse with one of slightly higher amp capacity than the surge amperes.

Check the main disconnect fuses first, then the control circuit fuses, then element bank and other component fuses.

NOTE 2: CHECKING FOR SHORT CIRCUITS
A short circuit will cause any one of the various fuses to fail. If any of the fuses are open, first replace the fuse, then try the circuit power. If the fuse fails again, it is likely that a short circuit has occurred. A short circuit is basically a wire path between two lines which has little or no resistance, thus causing an excessive amount of amperage to develop. This excess amperage causes the fuse to fail.

If a short circuit has occurred, trace the wire path according to the wiring diagrams. Check each connection to make sure that neighboring wires or connectors do not touch. Also check each line to ground with an ohm meter to make sure there are no grounded wires or connections.

NOTE 3: CHECKING PILOT LIGHT OPERATION
The on/off switch has a built-in pilot light which is on when the on/off switch is pushed on. If the pilot light fails to go on in either position of the on/off switch, then either a control fuse has failed, or the light bulb has burned out. Replace bulb and check fuses.

NOTE 4: CHECKING ON/OFF SWITCH OPERATION
With power off, hold ohm meter test leads between the center posts of the on/off switch, where wires are soldered. Have a helper push the switch on and off, and check the ohm meter. With the switch on, the ohm meter should indicate a closed circuit; it should indicate an open circuit with the switch off. If the meter does not change from open to closed circuit when the switch is changed from off to on, replace the contact block or the entire switch.

NOTE 5: CHECKING INPUT CONTROLS
With power on, set the input control to 100%. The temperature control must call for heat, and all door and back cut-off switches must be closed. At 100% setting, the respective power contactor(s) should close and remain closed for the full cycle. Keep at 100% setting for at least 90 seconds.

At smaller settings the input controls cycle the power contactors on and off. Lowest setting allows approximately 20% on time. If the input controls are not functioning properly, they should be replaced.

NOTE 6: CHECKING POWER CONTACTORS
With power off, isolate the power contactor coil control circuit by removing the control wires from it. VERY CAREFULLY, using a control voltage test lead (normally 120 volts), apply control voltage across the contactor coil. Contacts should close. If not functioning properly, replace coil or complete contactor.

NOTE 7: CHECKING TEMPERATURE CONTROL RELAY OPERATION
Turn power on. Set input controls to 100%, and control to 300°F. set point. Hold door cutoff switch closed and CAREFULLY heat the thermocouple probe with a match or lighter. Power contactors should close, and control indicator should climb to set point. Depending on setting of proportional band and other PID adjustments on the controller, the control should open the contactor just before the probe temperature reaches set point. If temperature control does not function properly, have it repaired or replace with a new one. See separate section in Maintenance section concerning control servicing.

NOTE 8: CHECKING DOOR AND BACK ELEMENT COVER CUT-OFF SWITCHES
The power contactors (and fan relay if included) are shut off whenever either the door is open, or the back element cover is taken off for service. This is a safety feature to shut off elements (and fan) whenever exposure to line voltage is possible. Power is restored when the door and back element cover is closed.

If switches do not function properly, check adjustment levers or bolts to make sure the switch is actuated when it should be. If not, adjust properly. If the switch is actuated, but circuit does not function

properly, first make sure the wiring is correct. Pay strict attention to whether the correct wires are connected to the proper pole of the switch (Common, Normally Open, Normally Closed.) Refer to the wiring diagrams. If wiring is correct, repair or replace the switch.

NOTE 9: CHECKING ELEMENT RESISTANCE VALUES

If the element resistance value is suspect, first call the factory for the correct resistance information. Then isolate one element by removing all wires from the posts on the element terminal block. Check resistance between the terminal posts with an ohm meter and compare with the factory value. Repeat as necessary. Replace if elements have aged too much and resistance is too high.

NOTE 10: CHECKING CONTROLLER INDICATION AGAINST STANDARD

Use a separate millivoltage source (a Biddle "Versa-Cal" calibrator is recommended) as the input signal to the control. Remove Thermocouple lead wires to the input terminals on the control. and attach test leads from the millivolt source. Turn power on. Set the millivolt source to a reading of 500°F. and compare control indication. Compare at 1000°, 1500°, 2000°, and 2300°F. The control manufacturer's instructions specify a certain range of accuracy for the control; compare any deviations noticed against the manufacturer's specifications, and contact the factory or control manufacturer if there is a problem.

Alternatively, send the control back to L&L Special Furnace Co.,Inc., for calibration service. There is a nominal charge, and a shipping procedure that must be followed. See the Parts List for information, and call the factory for Return Authorization.

NOTE 11: CHECKING CONTROL PID (THREE MODE) ADJUSTMENTS

Most controls sold with L&L Special Furnace Co.,Inc., furnaces are PID Three-Mode type time proportioning temperature controllers. These have a wide variety of adjustments that can be used for TUNING the controller to the actual process. This eliminates overshoot and undershoot or temperature droop. To check for proper tuning, set the control to a specific temperature and allow the furnace to rise to set point. Watch as the furnace approaches set point, and make sure the furnace temperature does not overshoot, undershoot, cycle too widely around set point, or never reach set point. If this occurs, see the section on the control operation in the Operation Instructions for specific instructions, and also read the control manufacturer's instructions. <u>PLEASE TAKE THE TIME TO READ THIS INFORMATION CAREFULLY BEFORE CALLING THE FACTORY.</u> Proper adjustment of the control is NOT a warranty item. An L&L Special Furnace Co.,Inc., technician is available on a per diem basis if necessary.

NOTE 12: CHECKING THERMOCOUPLE CIRCUIT

First inspect thermocouple weld for a good bead and no corrosion or erosion. The section on thermocouples in the Operation Instructions explains a great deal about actual thermocouple problems. If there is evidence of deterioration, replace the thermocouple. IT IS WISE TO KEEP A SET OF THERMOCOUPLES ON HAND FOR EMERGENCIES.

If the thermocouple itself is in good condition, trace the thermocouple extension wire circuit. Check for poor connections or broken leads.

NOTE 13: CHECKING THERMOCOUPLE POLARITY

Trace thermocouple extension wire circuit, making sure that all positive leads are connected together and all negative leads are connected together, with no cross wiring. See the Thermocouple section in the Operation Instructions for information on Polarity, and color codes.

NOTE 14: CHECKING TRANSFORMER TERMINALS FOR PROPER INPUT/OUTPUT VOLTAGES

The control transformer has a label describing proper terminals and jumpers for the line voltage and output control voltage of the system. Carefully compare the actual hook up with the label. Check output voltage from the transformer with a voltmeter. Change if necessary.

Note that the temperature control has a certain specified range of voltages within which it will operate properly. If out of this range, contact factory.

NOTE 15: CHECKING SUPPLY VOLTAGE

The furnace is designed to operate at a certain voltage, which is stamped on the furnace data nameplate. Check this against the actual supply voltage. A furnace designed for operation at 240 Volts will have only 75% of full power if operated at 208 volts, and control circuit voltage will not be within control manufacturer specifications. Contact the factory if it is necessary to rewire the furnace for a line voltage different from nameplate voltage.

NOTE 16: CHECKING INTERIOR TEMPERATURE OF CONTROL PANEL

The interior temperature of the control panel should not exceed 130°F. Check with an accurate thermometer while the furnace is operating. Pay careful attention to the critical control components, such as the controller chassis, and any exposed circuit boards. A control panel fan may be retrofitted into the panel, or the panel may be remounted onto a nearby wall away from the furnace. Extra hook up wire is available from the factory.

NOTE 17: CHECKING ADJUSTMENT OF INPUT CONTROLS

If chamber uniformity is not up to standards, check temperature difference between top and bottom zones using the thermocouple selector switch. (Most models except the DF, HB, and QD-29 are equipped with this feature.) If the top is hotter than the bottom, adjust the top input control to a setting below that of the bottom input control. Wait for about 30 minutes and read the difference again. Keep adjusting until uniformity is within specifications, normally +20°F. without a fan, and +15°F. with a fan. See the Operation Instructions for more information.

NOTE 18: EXCESSIVE BRICK WEAR

Excessive brick wear can be the result of various conditions. Most common is improper curing of the brick when first fired. FOLLOW THE INSTRUCTIONS IN THE INSTALLATION SECTION FOR THE FIRST FIRING AND CURING CYCLE!

All insulating firebrick is subject to expansion and contraction, which over time will lead to cracking and spalling. Spalling is the continued cracking of the brick which eventually results in large pieces of the brick falling out from the brick section. This is a normal condition as long as the emphasis is on eventually. Factors such as how close the furnace is operated at or near maximum temperature, how often and how fast the furnace is cycled up to heat and then cooled, how heavy the loads are, all figure into the brick wear equation. There is no set rule as to how long a brick lining will last. There are some L&L Special Furnace Co.,Inc. furnaces which are 25 to 30 years old with the original lining still in place; a good bet would be that these are not used very often or very hard. Others may have to have the lining replaced after 5 years of normal use. This is easy to do following the Maintenance Instructions.

Frequent door openings when the furnace is at high temperatures can cause thermal shock, leading to excessive cracking and spalling. Try to keep all door openings to a minimum, unless the furnace can be cooled first. If the door brick is wearing first, call the factory for possible replacement of the brick with ceramic fiber. This is not subject to the same degree as brick to thermal shock.

In some cases the seal brick wears first. A ceramic fiber tape seal can be installed to absorb mechanical and thermal shock. Call the factory.

NOTE 19: OPTIONAL HEARTH SYSTEMS

The standard hearth used in L&L Special Furnace Co.,Inc., furnaces is a cordierite ceramic type. Standard load weights are listed in the Installation section for each model. If the hearth cracks because of excessive weight or thermal shock, there are several alternative hearth types which may be used.

The silicon carbide hearth is an excellent choice for high temperature heat treating and in cases where thermal shock is a factor. Silicon carbide is also an excellent heat transfer material, which means that it will transfer heat from the bottom elements to the load more quickly than most other materials. It will also remain flat as it does not warp when subjected to thermal stress.

For processes under 2000°F., the 330 alloy hearth plate can be used. This is metal so it can warp, making it unsuitable for applications where heavy load must remain flat. However, it will not break or crack under stress; it will bend.

The stainless steel hearth plate is suitable for processes under 1400°F. Otherwise it is similar in all respects to the 330 alloy hearth plate.

L&L SPECIAL FURNACE COMPAN , INC.

LIMITED WARRANTY FOR ALLOY ELEMENT FURNACES (C 2)

Effective 3/1/91

This furnace is warranted by L&L Special Furnace Co.,Inc. to meet all quoted specifications unless changes are made and accepted by the customer. Furthermore, the furnace is warranted to be free of defects in material and workmanship for a period of one (1) year under normal usage with the exceptions stated below. Elements and thermocouples are warranted for six (6) months. All temperature controls, SCR power controls, transformers, recorders, and programmers are warranted by their respective control manufacturer under separate warranties. Alloy muffle, retorts, fans, castings and other alloy parts are not warranted against warpage, cracking or weld failure except in so far as the alloy fabricator of the component determines through his analysis that it is due to faulty material or workmanship. Ceramic and silicon carbide parts such as hearth plates are not warranted against breakage. Some packaged fan systems, such as those supplied by Industrial Gas Engineering, have their own separate warranty. Such warranty may be voided by not following operating instructions with regard to such things as cooling water flow. L&L will act as the intermediary in resolving any claims under separate control and component warranties but the determination of the original manufacturer of the component is final with regard to responsibility.

If any part needs repair or replacement during the warranty period, L&L will repair or replace the necessary items at no cost to the purchaser, except for transportation charges to and from the factory which the purchaser must pay. The purchaser must return all defective parts to L&L whereupon the purchaser will be issued a credit. If a service representative from L&L visits the purchaser's location for warranty work the customer will pay only for transportation and overnight expenses. If a service representative visits the purchaser's location for a problem not covered by this warranty, the purchaser will be billed at a rate of $55 per hour or travel and work time plus expenses. (This rate is subject to change.)

This warranty does not cover overfiring or firebrick cracking for any reason. Hairline cracks are a normal phenomena in furnace linings. **NOTE: If the furnace is not cured carefully according to the furnace instructions, the firebrick will crack extensively. This warranty specifically excludes protection for this.** <u>**BE SURE YOU FOLLOW INSTRUCTIONS.**</u> Moreover, be certain to examine the furnace very carefully upon arrival for cracks which may have occurred during shipment. The furnace is insured against this by the shipping company. **The furnace warranty does not cover shipping damages.**

The warranty does not cover normal shrinkage of ceramic fiber.

The warranty does not cover losses or damages caused by the malfunction of the control system or thermocouple. **We highly recommend the use of an overtemperature safety system.** Overfiring of the furnace for any reason, including but not limited to faulty controls, thermocouples or improper wiring, is not covered under this warranty.

Specific waivers of L&L rights in fulfilling th.. obligations of this warranty do not imply implicitly or explic.. / any future obligations not covered by this warranty.

Aspects of the furnace or system that are manufactured to customer specifications and which differ subtantially from the normal method of construction used by L&L will not be warranted except for materials and workmanship.

Payment for the furnace must be made according to agreed on terms or L&L may, at its option, void this warranty.

Use of improper atmospheres shall void the warranty unless otherwise stated in writing by an officer of L&L. **Unless specifically mentioned in writing, no explosive atmospheres may be used in the furnace. Such use will void the warranty and absolve L&L of any and all liability with respect to this furnace. A customer's process that generates atmospheres (such as but not limited to sulfur or florides) that are harmfull to the furnace may, at L&L's sole option, void the warranty.**

This warranty does not extend to the purchaser's process of manufacture or to the quality of the products processed in the furnace. The furnace is not warranted for any specific uses unless specifically stated in the quotation. L&L is not responsible for downtime costs and expenses associated with equipment failure or malfunction. This warranty is made only to the original purchaser of the equipment. L&L Special Furnace Co.,Inc. is not responsible for any consequential damages resulting from the malfunctioning of its equipment or for any other reason. L&L Special Furnace Co.,Inc.'s liability is expressly limited by L&L's terms and conditions of sale which are part of all quotations, invoices and acknowledgment forms. All technical advice, recommendations and services are rendered by L&L free of charge. While based on data believed to be reliable, such information is intended for use by skilled persons at their own risk. L&L assumes no responsibility to the purchaser for events resulting or damages incurred from use of such information on the part of the purcheser or L&L. Any advice given is not to be taken as a license to operate under or intended to suggest infringement of any existing patent.

COMPANY NAME: ROY F WESTON, INC/C/O: AAAP

ADDRESS: 14571 PLANT ROAD

CITY, STATE, ZIP: ALPINE, AL 35014

IMPORTANT INSTRUCTIONS
FOR FUTURE PARTS ORDERING
THE FOLLOWING INFORMATION MUST BE
GIVEN WHENEVER PLACING AN ORDER
FOR REPLACEMENT PARTS

MODEL NUMBER: FBG5610-F928-01-G310-480R3GF-I94

SERIAL NUMBER: I294LL

NO ORDERS WILL BE PROCESSED WITHOUT THIS INFORMATION

EACH L&L FURNACE IS UNIQUE, AND IDENTIFIED THROUGH THESE NUMBERS.

PLEASE KEEP THIS INFORMATION WHERE IT WILL BE EASILY AVAILABLE.

The model number gives us pertinent information about original drawings and electrical. Also all parts orders are filed with the original furnace file. While the serial numbers are kept separate and used as a source to double check. Also, changes made throughout the life of each furnace are kept in that furnace file. This helps L&L keep an up to date history on each furnace

VERSION: 3.0
MARCH 1, 1993
Prices subject to change without notice.

GENERAL PARTS LIST

Table of Contents

BEFORE ORDERING:

- COPY ALL THE INFORMATION FROM YOUR NAMEPLATE INCLUDING VOLTAGE, COMPLETE MODEL NUMBER, SERIAL NUMBER AND ELEMENT TYPE.
- WE ENCOURAGE USE OF FACSIMILE. OUR FAX NUMBER IS (215) 459-3689.
- PLEASE READ THIS PARTS LIST BEFORE CALLING.
- ASK FOR "PARTS ORDER DESK" WHEN ORDERING.
- THERE IS A SURCHARGE FOR RUSH ORDERS. (SEE LAST PAGE FOR POLICY.) NOTE THE DELIVERY TIMES FOR SPECIAL ORDER ITEMS. KEEP SPARES ON HAND, ESPECIALLY IF PRODUCTION IS CRITICAL.
- WHEN ORDERING ELECTRICAL PARTS HAVE WIRING DIAGRAM AT HAND.
- MINIMUM ORDER IS $50
- RESTOCKING CHARGE FOR STOCK ITEMS. NO ELEMENTS AND OTHER SPECIAL ORDER ITEMS MAY BE RETURNED. SEE LAST PAGE FOR POLICY.

ELEMENTS

ORDERING INFORMATION

(See also the specific sheet for your specific model number. This includes prices and part numbers.) When ordering elements, it is ESSENTIAL that you provide L&L with accurate data concerning the voltage, phase, element alloy and where the element(s) are located; i.e side, top, door. The basic information is written on the furnace nameplate. Several types of elements are used. Coiled metallic elements are most common: Iron-Aluminum-Chrome (Kanthal) and Nickel-Chrome (Nichrome). Kanthal is magnetic while Nichrome is not. Nickel-Chrome elements have a maximum temperature rating of 2100°F while Iron-Aluminum-Chrome elements go higher (up to 2350°F.) Silicon Carbide elements are used on GL, GB and GF Furnaces. Molybdenum Disilicide (Super Kanthal) Elements are used on GH Model furnaces. Molded ceramic fiber with embedded Kanthal elements are used for T3 series Tube Furnaces.

ELEMENT RESISTANCE AND CHANGE

It is possible to order one replacement element rather than an entire new set. However, element resistance does change with use. This can result in unbalanced heating and premature burnout of the new element. This is particularly true with silicon carbide elements which undergo a major change in resistance. If you have metallic elements and the other elements seem in good to fair condition (no severe brittleness or pockmarked oxidation) and if they are not too old (under 5 years or so), then you can take a reasonable chance by replacing them piecemeal.

ELEMENT DELIVERY

L&L maintains an excellent stock of all the element wire that we make alloy elements from. However, because of the large number of different elements (all the model numbers times the voltage and phase combinations), we do not stock the finished elements. Metallic elements are supplied in coiled form in tightly wound coils and the ends are doubled and twisted. **These must be stretched by you per the furnace instructions. All other elements are supplied by special order and delivery is dependent upon our suppliers. We suggest keeping spare elements on hand.**

OTHER PARTS TO CHECK WHEN ORDERING ELEMENTS

For metallic elements: When ordering elements, be sure that the ceramic insulator tubes (A-64), which isolate the element ends from the firebrick, and the ceramic bushings (A-1), which isolate the element ends from the metal inner back, are either in good condition or are ordered new. You will need two per element. NOTE: In some of the older P Model furnaces these insulator tubes were not included. It is recommended that you use them when you replace elements. On all other furnaces, be sure that any element insulator assemblies or tubes are in serviceable condition. Check the condition of the ceramic element holders. Replace any broken ones. If holders look like they are loose, order nichrome pins and cement.

ELEMENT CONNECTION BRAIDS AND CLIPS: (For GL, GLF, GB, GF & GH)

The element connection braids are the woven aluminum wire braids that connect the silicon carbide or molybdenum disilicide (Kanthal Super) elements to the element terminal board. The spring clips are the springs that attach the braids to the elements. Heat and age will wear these parts out and they should be replaced regularly as they oxidize. Check every six months. Specify Model Number and Length for all Element braids.

Element Braid for GB,GF,GLF,GL 15.00
(Non-stock. 2-3 weeks.)

Spring Clip for GB, GF, GLF GL $8.00
(Non-stock. 2-3 weeks.)
NOTE: Specify Model Number. Specify diameter of element.

Element Braid and clip set for GH series per quote
(Non-stock. 2-3 weeks.)
NOTE: Specify model number.

Aluminum Bolt and Hardware Set............. $8.00
(Non-stock. 2-3 weeks.)
NOTE: For GH Furnace element connections. Includes 5/8-18 x 2-1/2" aluminum bolt, two nuts, four washers and two spring washers. These are used because of the special high temperature and electrical requirements of GH furnaces. Price is per set.

INSULATION

FIREBRICK SECTIONS

Delivery is normally four to six weeks on brick sections. These are made to order. See the specific sheet for your model furnace or contact factory. The firebrick sections are cemented together and cut, routed and grooved on a very precise machine. These sections are sold as a section; i.e., a right side section or a top section. These sections are ready to install into the furnace with a minimal amount of fitting and no cementing. P Model furnaces come complete with new ceramic element holders already installed (All other furnaces have groves for holders but no new holders.) Normally the back up insulation needs to be replaced. Consult with a service technician when replacing firebrick for the recommended type and amount of backup insulation you will need. You may find it necessary to replace elements when you replace firebrick sections because used metallic elements become brittle and are likely to break when taken out of the furnace. Buy a Rubbing Brick (I-56) when doing any rebuilding (see below.) There is a fiber gasket in many furnaces between the side firebricks and the back firebrick (See I-47 - Ceramic Fiber 1/8" Thick Paper - under the Ceramic Fiber Board and Blanket Heading. This is also used behind the door firebrick in many cases.

CERAMIC FIBER DOORS

Furnace doors made of ceramic fiber are available for HB Series and XL Bench Model furnaces. These are lighter in weight, easier to open and close and have less breakage. Their cost is 1-1/2 times the standard firebrick door cost.

SINGLE FIREBRICK

NOTE: 2300°F Firebrick is used on XL, XT, TF, P Model, QD and HB Models. Most of these furnaces have the door seal lined with 2800°F Hard Firebrick for wear resistance. GL, GB and GF furnaces have 2800°F inside liners and may have backup firebrick liners of 2300°F Firebrick. 3000°F Firebrick is used on some special furnaces. Consult factory if necessary.

Single Soft Firebrick-2300°F.................. $5.00
I-52 (Stock)
NOTE: (2 1/2" x 4 1/2" x 9") These are the standard firebrick used on XL, HB and XT Series furnaces.

Single Hard Firebrick-2800°F $8.00
I-54 (Stock)
NOTE: (2 1/2" x 4 1/2" x 9")These are used on door seal and for hearth supports as well as in GB and GF Series furnaces.

Single Hard Firebrick-3000°F $10.00
(Non-Stock. 2-3 weeks. Must order at least 10 pieces.)
NOTE: (2 1/2" x 4 1/2" x 9") These brick are used in some very high temperature furnaces on a special basis. Also useful for extreme integrity and hardness. They have a high alumina content.

Rubbing Firebrick $15.00
(I-56. Stock.)
NOTE: This special very hard firebrick is used for rubbing down furnace seals and other brick repairs.

BACKUP INSULATION

2" Mineral Wool backup insulation $25.00
I-46 (Stock)
NOTE:Used for back up on most furnaces except on bottom. It is yellow in color when new. Price is per 24" x 48" piece. Customer must cut to suit.

2" Calcium Silicate Backup Insulation $50.00
I-62 (Stock)
NOTE: Hard white powdery insulation used on bottom of furnace and on some doors. Priced per 1 foot by 2 foot piece. Customer must cut to suit.

CERAMIC FIBER WALL AND ROOF MODULES

Delivery is normally four weeks. The fiber wall modules are sold as complete modules, and are in easy to handle sizes of 11-1/2" x 11-1/2" or less. These may be repaired temporarily per furnace instructions, and then replaced when convenient. Prices are per module. Smaller modules of the same thickness and temperature are priced the same. We must have the complete model number and location and the exact size of module metal backing for ordering information. A service techricain must be consulted when ordering.

FM-2000-A Fiber Module $70.00
IM-49-8 (Non-stock. 2-3 weeks.)
NOTE: 8" Thick. 4" of 2300°F Ceramic Fiber and 4" of mineral wool.

FM-2200-A Fiber Module $100.00
IM-49-9-2300 (Non-stock. 2-3 weeks.)
NOTE: 8" Thick. 4" of 2600°F Ceramic Fiber and 4" of mineral wool.

CERAMIC FIBER DOOR SEAL PARTS NOTE: Larger XL all TF and all FC , F and FN furnaces feature ceramic fiber door seal parts. Seal parts are by special quote only.

Top Door Seal Parts for XL and TF Furnace:

Fiber Top Door Seal for 24" wide furnace.... $250

Fiber Top Door Seal for 30" wide furnace.... $275

FiberTop Door Seal for 36" wide furnace $300

CERAMIC FIBER BOARD AND BLANKET

Door seals and other parts are made from ceramic fiber board. Normally the 2-1/2" thick 2300°F board is used. Price can be quoted for a complete seal or other part fabricated and cut to size from fiber board.

2-1/2" Thick 2400°FCeramic Fiber Board $40.00
(Stock.)
NOTE: Priced per square foot. Asumes a standard 3' x 4', 2' x 3' or 2' x 4' piece.

2300°F Ceramic Fiber 1/8" Thick Paper....... $15.00
I-47 (Stock)
NOTE: This is used for gasket material when rebuilding furnace and for some special applications. Price is per linear foot 24" wide

Ceramic Fiber Blanket 2300°F $3.00
I-49 (Stock)
NOTE: Price is per Isquare foot.

Ceramic Fiber Blanket 2600°F $5.00
I-41 (Stock.)
NOTE. Price is per Isquare foot.

CERAMIC FIBER TAPE FOR ATMOSPHERE SEALED CASES is listed under Atmosphere and Venturi Parts.

HEARTHS

HEARTH BRICK AND CASTABLE SECTIONS

This concems most FC, FN and some TF fumaces as well as many special designs. The firebrick sections are cemented together and then cut to close tolerances. See special sheet for part numbers. Castable sections are cast in molds. Castable is sold per the bag. L&L can cast sections for you. Castable pieces are by special quote per job.

Insulating Castable $55.00
I-65(Stock)
NOTE: Price is per 100 pound bag. 2200°F Material.

HEARTH SUPPORTS

Large Square Hearth Supports $9.00
A-12 (Stock)
NOTE: These are extruded ceramic square tubes 1-1/2" Square by 4" long. They can be used for any 2400°F hearth support. They will make the hearth stand 1-1/2" away from floor of fumace. 1/2" high hearth supports are also available. Use approximately 4 to 5 hearth supports per square foot of hearth area.

Small Round Hearth Supports............... $3.00
A-7 (Stock)
NOTE: 1/2" high by 3/4" diameter ceramic pieces.
NOTE: Hard firebrick (can also be used for hearth supports (Part I-54) These can be shaped by customer to suit installation.

CAUTION: Be sure not to cover elements with any hearth supports. Read instructions on hearth installation.

HEARTH PLATES

NOTE CONCERNING HEARTH MATERIAL: Standard hearths on XL, P Model, XT, TF, HB, B-86 are cordierite ceramic, normally 3/4" thick. Cordiente is a white to yellow color. Many customers have silicon carbide hearths which are thicker (up to 1-1/2" thick) and are a coarse black material. Silicon Carbide is stronger and has better heat conductivity properties. Alloy, either stainless steel 304, 330 or Inconel 600 Series are also occasionally used. Silicon carbide hearth plates (good to 2300°F), stainless steel hearth plates (good to 1400°F.), and 330 Alloy hearth plates (good to 2000°F.) can be purchased at any time. If you find that the standard ceramic hearth is cracking under the kind of use and conditions in which you operate, discuss your situation with your factory representative or the factory for a recommendation. You will also need hearth supports to raise the hearth off the bottom. See the specific sheet for your model number for prices or call the factory.

Silicon Carbide hearths are black and Cordierite hearths are white.

Silicon Carbide Hearths .... Per Quote
Delivery is normally 8 weeks

Alloy Hearths .... Per Quote
Delivery is normally 6 weeks

CEMENT, GROUT, MOLDABLE CERAMIC FIBER AND FACING COMPOUND

NOTE: All cements are packed in tight plastic cans which will not corrode. Shelf life is approximately one year.

1/2 Pint Brick Cement $14.00
IC-50-1 (Stock)

1 Quart Brick Cement $31.00
IC-50-2 (Stock)

1 Gallon Brick Cement $57.00
IC-50-3 (Stock)

1/2 Pint Brick Grout $15.00
IG-50-1 (Stock)

1 Quart Brick Grout $32.00
IG-50-2 (Stock)

1/2 Pint Brick Facing $14.00
IF-50-1 (Stock)

1 Quart Brick Facing $31.00
IF-50-2 (Stock)
NOTE: All the above cement, grout and facing is rated for 2800°F. Special cements for ceramic fiber board and higher temperatures are also available by special order. ***Cement*** *is for cementing firebrick and fixing small cracks.* ***Grout*** *is a mixture of cement and pulverized firebrick and is used for filling in larger cracks.* ***Facing*** *is a reflective coating applied to the surface of the firebrick which aides in sealing the firebrick and preventing dusting as well as aiding heat transfer.*

1/2 Pint Fiber-Coat 3000 .... $40.00
I-51 (Stock)

1 Quart Fiber-Coat 3000 .... $125.00
I-51 (Stock)
NOTE: Fiber-Coat 3000 Moldable Ceramic Fiber is good for 3000°F. this is used on door seals on atmosphere furnaces and for general patch work on ceramic fiber.

1/2 Pint Sali Moldable Fiber $85.00
(Non-stock. 2-3 weeks.)
NOTE: Moldable Sali Fiber is good for 3100°F (1700°C.) Normally only used on GH model furnaces. This moldable fiber is less malleable than the I-51 type moldable 3000°F fiber.

CERAMIC ELEMENT HOLDERS, CERAMIC PARTS AND ELEMENT TERMINATIONS

NOTE: Quantities and lengths of all ceramic parts must be specified by the customer. L&L does not keep records of exactly how many of each of these parts are used in each furnace.

AVAILABLE FOR ALL FURNACES

Nichrome Pins for Securing Holders $1.50
N-1 (Stock)
NOTE: Normally 2" long by 1/8" Diameter. These are used to secure the element holders if they become loose. Element holders can also be cemented in place.

ELEMENT HOLDERS SPECIFICALLY FOR FRONT LOADING P MODELS

NOTE: The die number on the following is #541. Single slot is key hole shaped. Elements must be pulled out.

6" Long Single Slot Element Holder $7.00
A-15-541-6 (Stock)

4" Long Single Slot Element Holder $6.00
A-15-541-4 (Stock)

Special Cut End Holders $12.00
A-15-541-E (Non-stock. 2-3 weeks.)
NOTE: These are notched to fit between a pair of holders.

ELEMENT HOLDERS USED ON MOST TOP LOADING MODELS (P AND XT)

NOTE: The die number on the following is #542. Single slot allows element to be lifted out of the holder.

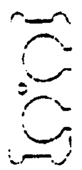
6" Long Top Loader Element Holder $7.00
A-14-542-6 (Stock)

4" Long Top Loader Element Holder $6.00
A-14-542-4 (Stock)

ELEMENT HOLDERS FOR ALL XL, TF, QD (except QD-29), HB-24, HB-12, AND BK MODELS:

Element End Pins.......................... $1.25
(Stock)
These are the 3/8" diameter ceramic pins that are cemented into the brick at the end of the element. One needed per element.

NOTE: The die number on the following element holders is #952. Double slots are key hole shaped. Elements must be pulled out.



6" Long Double Slot Element Holder.......... $8.75
A-65-952-6 (Stock)

4" Long Double Slot Element Holder.......... $8.25
A-65-952-4 (Stock)

1-1/2" Long Double Slot Element Holder....... $6.75
A-65-952-1-1/2 (Stock)
NOTE: Other lengths of element holders may no longer be available. Some 3" and 4-1/2" holders are still available for the same price as the 4" and 5" for the price of the 6" holders. Special cut holders can be made up at $.50 per cut.

ELEMENT HOLDER PLATES FOR QD-29, HB-9, HB-29, B-86

NOTE: These are flat plates with several rows of key shaped slots.

HB-9 and B-86 Element Plate............... $75.00
A-17-9 (Stock)

HB-29 Front Element Plate.................. $80.00
A-17-29F (Stock)

HB-29 Back Element Plate.................. $80.00
A-17-29B (Stock)
NOTE: Each side has two separate plates which must be specially cut to fit together. You must specify right or left and back or front or both.

Order Ceramic Busings (A-1) and Inculator tubes (A-64) when ordering elements. You need two of each per coiled element.

COMPLETE ELEMENT SETS FOR HB, B-86, QD-29

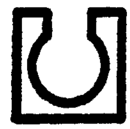
Includes ceramic plate with elements installed.

HB-9 or B-86 Complete Side Element....... $190.00
(Non-stock. 2-3 weeks.)

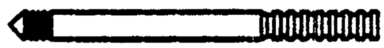
HB-29 or QD-29 Complete Side Element.... $375.00
(Non-stock. 2-3 weeks.) Specify right or left.

ELEMENT HOLDERS USED ON FM MODELS:

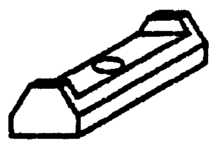
12" Long Single Slot Holder................. $6.00
A-9-1297 (Stock)



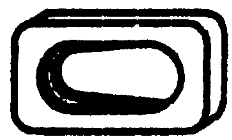
Ceramic Fluted Bolt....................... $8.75
A-8-1297 (Stock)



Ceramic Clamp........................... $5.50
A-10-1297 (Stock)



Ceramic Washer.......................... $2.50
A-11-1297 (Stock)



FM Element Holder Set.................... $45.50
A-S-1297 (Stock) (Includes two each of all four above items. This provides enough ceramic parts for a 12" section of element.)

Special Ceramic Bolt Tightening Tool....... $75.00
FM-BTT (Non-stock. 2 weeks.)

Lag Bolt Tool........................... $55.00
FM-LBT (Non-stock. 2 weeks.)

ELEMENT TERMINATION COMPONENTS

HB-9 or B-86 Terminal Board............... $50.00
E-53-9 (Non-stock: 2 weeks)

HB-29 or QD-29 Terminal Board $55.00
E-53-29 (Non-stock: 2 weeks)

Ebony Terminal Board with Screws $70.00
(Non-stock:3-4 weeks)
NOTE: Each one is special. Measurements from you may be required. Consult Service Technician. These where not used in XL and TF models after 1981. Non-asbestos material is used.

Small Round Terminal Board Standoffs........ $3.00
A-7 (Stock)
NOTE: 1/2" high by 3/4" diameter ceramic pieces.

Element End Insulator Tube: 9" Long $3.75
A-64 (Stock)

NOTE: This is a single hole ceramic tube 3/8" Outside diameter, 1/4" inside diameter. Used on all metallic element furnaces. Can be cut or broken by customer to fit exact length required. These are used to shield element end as it protrudes through the firebrick and backup insulation.

Double Hole Element Terminal Block......... $17.00
A-35 (Stock)
NOTE: This is the molded ceramic block used as a double hole bushing and element terminal block. Used on post 1982 XL, XT, TF, FM furnaces. Supplied with proper 1" diameter plated washers and bolts attached.

Single Hole Ceramic Bushing $3.75
A-1 (Stock)
NOTE: This looks like a mushroom with a 3/8" hole in the center. The insulator tube (Part A-64) fits into it. The bushing fits into a round hole in the furnace case. This part is used on pre 1982 XL, TF and XT furnaces and all P, AA, and TT furnaces. It is not used where the all ceramic terminal block is used (Part A-35).

Large Single Hole Ceramic Bushing........... $4.50
(Stock)
NOTE: These are used on some TB furnaces where there is a molded ceramic fiber element with a wide flat element terminal end. They are not standard.

9" long Alumina Element Protection Tube..... $40.00
(Non-stock: 4-6 weeks
NOTE: For Silicon Carbide Element furnace: GL,GB,GF Models. These are different lengths for GL and GB

7" long Alumina Element Protection Tubes
.. $35.00
(Non-stock: 4-6 weeks)
NOTE: For Silicon Carbide Element furnace: GL,GB,GF Models. There are different lengths for GL and GB

CONTROLS

NOTE: All control orders must be checked by a factory engineer or service technician to insure proper selection. Alarms, event switches and SCR type 4-20 milliamp output will add to these listed prices.

Honeywell UDC 3000 Single Set Point Control $550.00
(Stock)
NOTE: This is standard on XL, TF and most other L&L Furnaces.

Honeywell UDC 3000 Program Control $1,050.00
(Stock)

Retrofit UDC 3000 single set point to make it a program control $500.00

Honeywell UDC 2000 Single Set Point Control $350.00
Honeywell DR450T Recorder............. $1250.00

Chessel Model 300 Strip Chart Recorder ... $1250.00

Chessel Model 345 Strip Chart Recorder ... $1850.00

NOTE: Above prices are for single pen recorders only.

CHART PAPER AND PENS FOR RECORDERS MUST BE ORDERED DIRECTLY FROM THE CONTROL MANUFACTURER.

NOTES ON ALL CONTROLS:

1. Standard Type is 0-2500°F Range with a Type K Thermocouple. However, you must provide the complete model number of the control because of the many special controls in the field. See control chasis or wiring diagram.

2. Barber Colman, Honeywell, Leeds and Northrup, Research Inc. and many other controls are available by special order. Consult factory.

3. Older P Model furnaces without controls can be converted. Consult factory service technician.

4. Older Partlow, Watlow, West and Honeywell Dialapak controls can be directly replaced with new Honeywell digital controls. Rewiring diagrams available.

5. Honeywell controls are available on a loan basis (depending on inventory availability) for $100 per loan period while your control is being serviced by the control manufacturer.

6. Most microprocessor based controls can have their scales calibrated for Degrees C or F and the thermocouple type changed in the field. Consult your control instructions or the factory if this is ever necessary.

THERMOCOUPLES AND THERMOCOUPLE SELECTOR SWITCHES

10" long Type K Open Thermocouple $70.00
TK-1-10 (Stock)
NOTE: Standard Type is 10" Long and has an exposed end Known as T/C on electrical wiring diagram. It is Chromel-Alumel.

7" long Type K Open Thermocouple $70.00
TK-1-7 (Stock)
NOTE: Same as above but for bench models with less insulation thickness. For HB Series and XL bench models such as XL 112 and XL 124.

10" long Type K Open T.C. with 18" long leads $90.00
NOTE: These are used on many of the older "P" models. The thermocouple hooks directly to the control without any lead wire.

Type K Thermocouple Terminal Board $25.00
T-TB (Stock)
NOTE: Known as T/C on electrical wiring diagram.

Small Round Thermocouple Standoffs $3.00
A-7 (Stock)
NOTE: 1/2" high by 3/4" diameter ceramic pieces.

NOTE ON OLD P MODELS: On some old P models there was a very long thermocouple that attached directly to either a control or a pyrometer. This must be converted over to the new system. Buy a TK-1 thermocouple, a Thermocouple Terminal Board (T-TB), standoffs and the proper length of Type K Thermocouple Extension Wire (T-10) and hook this up according to the supplied instructions.

Type R Thermocouple $300.00
(Non-stock: 3-4 weeks)
NOTE: This is Platinum/Platinum-Rhodium 13%. The control must be calibrated for this Type R thermocouples are for higher temperature use. They are used on all GL, GF and GB series furnaces. The standard Type R thermocouple has a 3/8" diameter alumina protection tube with no head. The length of the thermocouple must be specified.

Type R Dual Element Thermocouple $425.00
(Non-stock: 3-4 weeks)

Type B thermocouple $300.00
(Non-stock: 3-4 weeks)
NOTE: Used in GH Model furnaces only. For use to 3100°F. Includes a cast head. Use regular copper wire for extension wire. Known as T/C on electrical wiring diagram.

Type B Dual Element Thermocouple $425.00
(Non-stock: 3-4 weeks)

Flexible Type K Sheathed Thermocouple $100.00
T-32 (Non-stock: 3-4 weeks)
NOTE: This looks like miniature single cable with serrated flexible inconel sheathing around the thermocouple. Maximum temperature use is normally 2000°F but can be used intermittently at higher temperatures. Known as FT/C on electrical wiring diagram. Length must be specified.

Inconel Sheathed Type K Thermocouple $100.00
T-34 (Stock)
NOTE: With inconel protection tube and cast aluminum head. Maximum temperature use is normally 2000°F but can be used intermittently at higher temperatures. Specify length of protection tube. Known as T/C on wiring diagram.

Mullite Sheathed Type K Thermocouple $125.00
(Non-stock: 3-4 weeks delivery)
NOTE: With mullite protection tube and cast aluminum head. Maximum temperature use is normally 2350°F. Specify length of protection tube. Known as T/C on wiring diagram.

Stainless Sheathed Type J Thermocouple... $100.00
(Non-stock: 3-4 weeks)

Type J Thermocouple Extension Wire $2.50
T-14 (Stock)

Type K Thermocouple Extension Wire $2.50
T-10 (Stock)
NOTE: This is brown in color. Priced per foot.

Type K Shielded TC Extension Wire $3.00
T-40 (Stock)
Note: This is for electrically noisy environments.

Type R Thermocouple Extension Wire $2.50
T-12 (Stock)
NOTE: This is green in color. Priced per foot.

Standard Thermocouple Selector Switch..... $35.00
E-17 (Stock)
NOTE: This looks like a simple toggle switch. It is a special switch which will not affect the thermocouple readings. Do NOT use a normal switch. Generally known as TGS on electrical wiring diagram.

NEMA 13 Thermocouple Selector Switch..... $65.00
E-97 (Stock)
NOTE: This is an oil tight switch. It has a black plastic turn type knob/pointer. Generally used in JIC control systems. Known as SS on electrical wiring diagram.

GENERAL ELECTRICAL COMPONENTS

IMPORTANT NOTE FOR ALL ELECTRICAL COMPONENTS: *Check your wiring diagram carefully for exact part number information. The information on these pages should help you identify the part; however, because of the wide variation of electrical components and many changes and improvements over the years, it is impossible to catalog all parts in the parts list. The wiring diagram has complete specifying information in the Sequence of Operations section. Have the wiring diagram handy when placing an order. Be sure to provide complete voltage and nameplate information as well. Any part not listed here is by special quote.*

ZONE CONTROLS:

INF Infinite Rate/Zone Controls $37.50
E-16 (Stock)
NOTE: Known as SM on electrical wiring diagram. These control the amount of time each zone is on relative to the other zones. The standard type used on all XL, TF, XT, and QD Furnace are 120 volts and only affect the control circuit. Most older P Models directly controlled the voltage to the elements and so voltage of the elements determines the voltage of the INF switch: i.e. 120, 208 or 240. Voltage rating is printed on the switch. Very old type of D.T. Switch is no longer used. Wiring Conversion Sheet is available to convert to INF switch.

Zone Switch Knob.......................... $8.50
H-8 (Stock)
NOTE: Round black knob that turns the zone or input switches on most XL/HB and TF furnaces.

ATC Percentage Timer.................... $150.00
(Non-stock: 2-3 weeks)
NOTE: Known as SYNMTR on electrical wiring diagram. These are used instead of the INF Switches on JIC control systems. They perform the same function.

INTERLOCK SWITCHES

Long Arm Type Door Cut Off Switch $40.00
E-26 (Stock)
NOTE: Known as LS-A on electrical wiring diagram. These are used to shut off power to the elements when the door is opened. This type is used on the HB Models, some P Models, the QD-29 and XL Bench Models. It is a micro switch with a long metallic reed/actuator.

Power Panel Cut Off Switch................. $40.00
E-26 (Stock)
NOTE: Known as LS-B on electrical wiring diagram. Used to cut off power to element connection area when the cover panel is not in place. The same switch as mentioned above. Used in all post 1984 furnaces.

NEMA 13 Door Cut Off Switch $70.00
E-43 (Stock)
NOTE: Known as LS-A on electrical wiring diagram. Used on Floor Model XL, XT, TF, Larger QD and most other furnaces. Oil tight sealed switch with button actuator.

POWER CONTACTORS

NOTE: All known as CR on electrical wiring diagram

ALL CONTACTOR ORDERS SHOULD BE REVIEWED BY A FACTORY SERVICE TECHNICIAN FOR ACCURACY AND PRICING

2 pole 30 Amp Mechanical Contactor $50.00
NOTE: Part description: PRD7AYO or equal. Used on some smaller bench furnace overtemperature systems and P Models. Used for single pole contactor as well.

3 pole 50 Amp Contactor.................. $100.00
NOTE: Replaces 3-pole R4214G 1032. Used on most overtemperature control systems.

1 pole 15 Amp Mercury Contactor $85.00

2 pole 35 Amp Mercury Contactor $115.00

3 pole 35 Amp Mercury Contactor $225.00

2 pole 60 Amp Mercury Contactor $275.00

3 pole 60 Amp Mercury Contactor $350.00

2 pole 100 Amp Mercury Contactor $350.00

3 pole 100 Amp Mercury Contactor $385.00

NOTE: SCR power controls are by special order. 4-6 weeks delivery is normal. Be sure to keep SCR fuses on hand. They are not stock.

FUSES AND FUSE BLOCKS

FUSES AND FUSE BLOCK ORDERS MUST BE REVIEWED BY A FACTORY SERVICE TECHNICIAN FOR ACCURACY AND PRICING.

NOTE ON VOLTAGE: 240 volt furnaces use 250 volt electrical equipment. 460, 480 and 575 volt furnaces use 600 volt electrical fuses and fuse blocks. All fuse information is on the wiring diagram. Use this information for specifying. Fuses are known as F on wiring diagram. **Most fuses are in stock at factory.**

250 Volt 2 Pole 30 Amp Fuse Block $11.00

250 Volt 3 Pole 30 Amp Fuse Block $17.00

250 Volt 2 Pole 60 Amp Fuse Block $15.00

250 Volt 3 Pole 60 Amp Fuse Block $19.00

250 Volt 1 Pole 100 Amp Fuse Block $20.00

600 Volt 2 Pole 30 Amp Fuse Block $17.00

600 Volt 3 Pole 30 Amp Fuse Block $18.00

600 Volt 2 Pole 60 Amp Fuse Block $20.00

600 Volt 3 Pole 60 Amp Fuse Block $23.00

600 Volt 1 Pole 100 Amp Fuse Block $30.00

HPK Fuse Holder $10.00

250 Volt Fuse 30 amps $1.50

250 Volt Fuse 60 amps $2.25

250 Volt Fuse 100 amps $10.00

250 Volt Fuse 200 amps $25.00

250 Volt Fuse 400 amps $50.00

600 Volt Fuse 30 amps $7.00

600 Volt Fuse 60 amps $10.00

600 Volt Fuse 100 amps $22.00

600 Volt Fuse 200 amps $50.00

600 Volt Fuse 400 amps $110.00

Control Fuses (specify amperage) $2.00

TERMINAL BOARDS

MOST TERMINAL BOARDS ARE IN STOCK. Delivery can take 6-8 weeks on special terminal boards.

Main Power Terminal Board (>100 amps) $40.00
E-129 (Stock)
NOTE: Power terminal boards are the terminal boards where the main power to the furnace is connected. Known as ITB on wiring diagram.

Main Power Terminal Board (<100 amps) $125.00
E-30 (Stock)
NOTE: Consult with ser ice technician for proper selection.

MAR type terminal boards $10.00
NOTE: Must be specified by number on wiring diagram; i.e. MAR 202 or MAR 1604. Known as 2TB, 3TB, etc on wiring diagram.

CONTROL TRANSFORMERS

NOTE: Known as IT on wiring diagram. Use wiring diagram to specify exact rating and voltage of transformer or look on transformer. Most are in stock. Special transformers can take 3-4 weeks. Consult service technician for proper selection.

Standard 240/480 to 120 Volt .25 KVA $160.00
E-47 (Stock)

208 volts to 120 Volt .25 KVA $200.00
E-49 (Stock)

575 volts to 120 Volt .25 KVA $205.00
E-48 (Non-stock. 3-4 weeks.)

Standard 240/480 to 120 Volt .75 KVA $225.00
E-47 (Stock)

208/575/special volts to 120 Volt .75 KVA $250.00

ON/OFF SWITCHES

Standard NEMA 13 Lighted On/Off Switch $65.00
E-92 (Stock)
NOTE: Known as MPB on wiring diagram. Includes lightbulb.

It is recommended that you purchase extra bulbs for the lighted NEMA 13 switches.

Light Bulb for standard NEMA 13 Switch $3.00
E-93 (Stock)

Toggle Type On/Off Switch $25.00
E-17 (Stock)
NOTE: Known as TGS on wiring diagram. Used on B-86. Metallic type toggle.

Plastic Lighted Toggle On/Off Switch $22.00
L-2[illegible] (Stock)
NOTE: Known as TGS on wiring diagram. Used on CT, some old HB Models. Rectangular in shape.

WIRE

NOTE: All wire is priced per foot

4 Wire SO Cord $8.00
E-44

6 Wire SO Cord $12.00
E-45
NOTE: This is the wire that connects elements in the door. Some furnaces have 4 wires and some have 6 wires.

4 Gauge High Temp Power Wire (THHN) $1.50
6 Gauge High Temp Power Wire (THHN) $1.00
8 Gauge High Temp Power Wire (THHN) $0.75
10 Gauge High Temp Power Wire (THHN) $0.60

4 Gauge High Temp Power Wire (SMRL) $5.00
6 Gauge High Temp Power Wire (SMRL) $4.00
8 Gauge High Temp Power Wire (SMRL) $3.00
10 Gauge High Temp Power Wire (SMRL) $1.50

14 or 16 Gauge Control Wire $0.25
NOTE: Specify color. E-196=Green. E-198=Red. E-197=White.

Special Very High Temperature Power Wire
NOTE: Used in GB and GF Series in the element connection panels and in some other special furnaces. By special quote only. this is MG and TGGT Grade Wire.

FAN PARTS

12" DiamFan Blade Assembly $1400.00

NOTE: Specify whether it is a cast 6 bladed radial flow-with pitched blades- or a 4 bladed paddle wheel type. Specify type which is used. Specify shaft diameter. Generally this would either be 3/4" or 1-3/16" diameter.

14" Fan Blade Assembly $1600.00
H-75 (14" Diameter with 6 blades. 1-3/16" shaft)
(Non-stock: 4-6 weeks)
Specify shaft diameter and length of shaft.

Fan Blade Assembly (For Bench Unit) $700.00
F-1 (Non-stock: 3-4 weeks)
Note: Specify the length and whether it is direct drive or belt driven type.

3/4" Fan Pillow Block Bearings $45.00
R-144 (Stock)

1-3/16 Fan Pillow Block Bearings $80.00
R-146 (Stock)

Fan Motor For Floor Mounted Furnaces $375.00
(Stock.)

Fan Motor For Bench Mounted Furnace $175.00
(Normally stock.)
NOTE FOR FAN MOTORS: Check wiring diagram for exact part number of fan motor. Fan motors known as FMTR on wiring diagram. Specify voltage.

3/4" Aluminum Heat Dissipator $60.00
M-22 (For Bench Models) (Stock)
NOTE: Specify inside diameter and height.

1-3/16" Aluminum Heat Dissipator $85.00
M-45 (For Floor Model Fans) (Stock)
NOTE: Specify inside diameter and height.

ATMOSPHERE AND VENTURI PARTS

3 Oz Silicone Sealant $12.00
H-64 (Stock) Price is per Tube.

10.3 Oz Silicone Sealant $25.00
H-64 (Stock) Price is per Tube.

Bench Model Linde Flowmeter/Regulator $600.00
H-61 (Stock) Model SSA 607580. (1-13 LPM scale.)

Floor Model Linde Flowmeter/Regulator $600.00
H-62 (Stock) Model SSA 609580. 93 CFH Max Flow. ((4-44 LPM scale)

6" Wide Woven Ceramic Fiber Tape $19.00
I-63 (Stock)
NOTE: Used on Floor model furnaces as the door gasket material. Price per foot. Specify length

3" Wide Woven Ceramic Fiber Tape $13.00
I-63 (Stock)
NOTE: Used on Bench model furnaces as the door gasket material. Price per foot. Specify length

NOTE: When replacing ceramic fiber door seal order staples shown below and furnace cement.

Nickel-Chrome Wire Staples $2.50
(Stock)
NOTE: These are for securing woven ceramic fiber tape ontot he firebrick seal. They are 2" high by 3" wide.

Stainless Steel Foil Wrap $120.00
(Price is per 50 foot roll by 24" wide.)
NOTE: This is used for protecting from oxidation and decarburization rather than using a protective atmosphere.

MISC SPECIAL ORDER PARTS

NOTE: The following items are by special order: Motorized Venturi (Without Damper), Stainless Steel Air Operated Venturi, Stainless Steel Damper (Manually or Pneumaticly Operated, Pneumatic Cylinder for Pneumatic Damper plus many other options and custom items too numerous to mention.

MISCELLANEOUS

HARDWARE

Rheostat Knobs for the INF Switches $8.50
H-8 (Stock)

Door latch: Small Push Type Clamp $35.00
H-3 (Stock)
NOTE: Used on some horizontal bench model doors.

Door latch: Large Push Type Door Clamp..... $40.00
H-24 (Stock)
NOTE: Used on floor model horizontal door on right hand side normally.

Door latch: Pull Type Door Clamp $35.00
H-25 (Non-stock: 2-3 weeks)
NOTE: Used on floor model horizontal door on left hand side normally.

Door latch: Oven type Brixton spring latch.... $40.00
H-13 (Stock)
NOTE: Chrome plated. Includes the latch and catch Explosion relieving type. Used on QD-29 and B-86 and on special furnaces. Some larger galvanized latches are used on occasion. Check with service technician if yours is not chrome plated.

Main Door Spring for HB and QD-29 .... $35.00
H-82 (Stock)
NOTE: Used on the vertical spring loaded Bench Model doors.

Main Door Spring for XL Bench Models $40.00
H-81 (Stock)
NOTE: This is a more forceful spring needed because of the greater weight of the XL door. For XL 112, XL 124, XL 126 and XL 894.

Safety Spring **$7.50**
H-1 (Stock)
NOTE: This is the small spring that goes inside the main spring and protects the operator in case the main spring breaks.

Eyebolt to hold main Spring **$8.00**
H-2 (Stock)

Bakelite Handle/Knob **$10.00**
H-9 (Stock)
NOTE: for Bench Model Door Handle. Round high temperature black plastic.

PEEPHOLE PARTS

Complete ceramic peephole assembly **$150.00**
(Stock)

Peephole glass **$25.00**
A-60 (Stock)
NOTE: the above peephole parts are for 2350°F Maximum temperature use. High temperature peepholes by special order.

LOADING ACCESSORIES

Loading Tongs (See Options Brochure) **$110.00**

Loading Hook **$75.00**

Heat Resistant Gloves **$75.00**
(Non-asbestos, cover up to elbow.)

TOUCH UP PAINT

Silicone Based 800°F Black Paint **$14.00**
Spray Can (Stock)

Gray Enamel Paint **$12.00**
Spray Can (Stock)

Zinc Chromate Primer **$11.00**
Spray Can (Stock)

TECHNICAL INFORMATION AND SERVICE

INSTRUCTIONS

Complete Instruction Book **$75.00**
(Made to Order: 1-2 weeks)
NOTE: The exact model number and serial number are needed. Includes wiring diagrams.

Wiring Diagram Set **$25.00**
(Stock)
Note: Older P Model Furnace instructions can be included with the wiring diagram for no extra charge.

FIELD SERVICE

$550 per day or $55 per hour (including travel time) whichever is less plus all travel and $125 per diem lodging expenses. A purchase order must be issued in advance for this service. On warranty work, the labor charge will be waived; however, all travel and per diem lodging expenses must be paid.

COMPLETE REBUILDING SERVICE

L&L can completely rebuild your furnace. The furnace must be shipped freight prepaid to L&L. This can be done by Common Carrier because shipping damage will not matter. When the furnace is finished it will be sent back freight collect by air ride moving van. A complete rebuilding job includes totally relining the furnace with new insulation and installing new elements and thermocouples. The controls, if sent back, are recalibrated and the furnace is tested before shipment. If any rewiring needs to be done, this will be quoted as extra at the factory. On some older furnaces there is no door safety interlock switch. L&L RECOMMENDS THAT THIS BE RETROFITTED ON ALL OLDER FURNACES. If L&L does the rebuilding work, this will automatically be done. The charge for this is the price of the Door Interlock Switch plus $75 labor.

TERMS AND POLICIES

PACKING CHARGES

Packing charges range from $4.00 for a small package to $75.00 for a skidded carton. Some large firebrick orders can take two or more skidded cartons and almost all firebrick orders must be shipped in a skidded carton. A price will be quoted upon request. <u>This charge will be added to the invoice whether quoted or not.</u>

MINIMUM ORDERS

The minimum order is $50.00. If your order is under that, we recommend that you order a spare thermocouple.

SHIPMENT

All orders are F.O.B. Aston, PA. Shipment is by UPS when possible (under 70 lbs) and, when necessary and practical, orders may be broken into several packages to avoid the use of common carriers. Air shipment by UPS Overnight Red Label Service, 2nd Day Air or Federal Express or Emery is available at cost. All orders are shipped freight collect except for UPS. UPS charges are added to the invoice.

TERMS

All orders are shipped COD unless proper credit has been established prior to ordering. All prices are subject to change without notice. Be sure you get updated prices before placing an order, especially if your price sheet is more than one year old (See page one of this booklet for date.)

PURCHASE ORDERS

All verbal purchase orders must go COD regardless of credit worthiness. A written purchase order must be recieved by us (FAX is OK) is necessary to ship on terms.

SALES AND USE TAXES

L&L collects sales tax in Pennsylvania, Texas, California and the State of Washington. We must have a valid tax exempt form from you if you are exempt from sales tax. We must know what the reason for the exemption is. An exempt number printed on the purchase order is not acceptable. In all other states, the [illegible] is responsible for paying taxes to the proper authority.

RESTOCKING AND RETURNS

Only stock items will be accepted for return. No elements or non-stock items will be accepted. There is a 25% restocking charge with a minimum restocking charge of $25.00.

DELIVERY AND RUSH ORDERS

Normal delivery is quoted at 7 to 10 days for standard in-stock parts and metallic elements. Brick normally takes four to six weeks. Expedited delivery is available for a $50 to $100 charge (or more in special cases) plus any special shipping charges. The amount charged depends on whether production scheduals will be interupted. Check when ordering.

RECOMMENDED SPARE PARTS TO KEEP ON HAND

NOTE: The following is typical for a standard XL Furnace:

2 thermocouples
2 Elements of each type (i.e. door/back and side/top/bottom.)
1 Contactor (if you have mechanical contactors)
1 Complete Set of Fuses of every type used
1 Hearth Plate Set
2-6 Hearth Supports
1/2 pint of firebrick cement
1 Quart of Brick Facing
4 Ceramic Insulator Tubes (A-35)
2 Terminal Blocks
1 Hard Firebrick
1 Soft Firebrick
5 Element Holders of every type used in the furnace
1 INF Switch (Zone Control)
1 Can Touch Up Paint

RECORDER CHART

This chart represents an actual test run of the control system included with the furnace. This test has been run with a special test facility at L & L SPECIAL FURNACE CO. INC.'s factory, which includes a specially designed fast firing furnace. The fast heat up rate recorded on the chart is not necessarily an indication of how quickly the furnace shipped will come to temperature.

This test indicates how closely the controller controls at set point and how quickly it stabilizes at the desired set point. In certain instances the chart will indicate (by oscillations) where L & L personnel have made adjustments on the controller to stabilize the control action.

In most cases the controller will have to be adjusted by the user to conform to local voltage conditions, and to actual loading conditions in the furnace itself. Instructions for this procedure are included in the furnace instruction manual.

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UDC 5000
Universal Digital Controller
Product Manual

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9/94

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Honeywell
Industrial Automation and Control
Automation College
2820 West Kelton Lane
Phoenix, AZ 85023

About This Publication

How this manual is organized

This Product Manual is divided into 12 sections. These sections contain all the information you need to configure, operate, monitor, and troubleshoot your controller.

To find information quickly, use the comprehensive Table of Contents in the front of the manual and the Index located in the back of the manual.

Warranty

The device described herein has been manufactured and tested for correct operation and is warranted as follows:

The UDC5000 Universal Digital Controller carries a two year warranty. This warranty includes immediate technical assistance via a toll free telephone number and complete replacement of the controller, if necessary.

Technical Assistance

If you encounter a problem with your UDC5000 controller, review all the configuration data under the Set-up groups to verify that your selections are consistent with your application; i.e. Inputs, Outputs, Alarms, Limits, etc. If the problem persists after checking the above, you can get technical assistance by dialing

1-800-423-9883	USA
1-800 461-0013	Canada

An engineer will discuss your problem with you. Please have your complete model number, serial number, and Software version available. The model and serial numbers can be found on the chassis nameplate. The software version can be viewed under Setup Group "Status." See *subsection 9.4*.

If it is determined that a hardware problem exists, a replacement controller or part will be shipped with instructions for returning the defective unit. Do not return your controller without authorization from Honeywell's Technical Assistance Center or until the replacement has been received.

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Acronyms

EMI	electromagnetic interference
HID	high intensity discharge
MOVs	Metal Oxide Varistors
NC	normally closed
NO	normally open
PID	Proportional, Integral, and Derivative
RC	resistance-capacitance
RFI	radio frequency interference
RH	Relative Humidity
RTD	Resistance Thermometer Device
SCRs	Silicon controlled rectifiers
UDC	Universal Digital Controller

Parameters

A1S1 VAL	Alarm 1, Setpoint 1 Value
A1S1TYPE	Alarm 1, Setpoint 1 Type
A1S1 HL	Alarm 1, Setpoint 1 State
A1S2 VAL	Alarm 1, Setpoint 2
A1S2TYPE	Alarm 1, Setpoint 2
A1S2 HL	Alarm 1, Setpoint 2 State
A2S1 VAL	Alarm 2, Setpoint 1
A2S2TYPE	Alarm 2, Setpoint 2 Type
ACTION	Control Output Direction
ADAPTIVE	Autotune Type
AL HYST	Alarm Hysteresis
ASTP	automatic step change
AT ERROR	Autotune Error codes
AUTO	Lower display automatically displays setpoint value in engineering units
AUX OUT	Auxiliary Output Option
BAUD	Baud Rate
BIAS IN1	Input 1 Bias Value
CAL TEST	Calibration test failure
Com ADDR	Communications Station Address (Loop 1) RS422 or DMCS
Com ADDR2	Communications Station Address (Loop 2) RS422 or DMCS
ComSTATE	Communications Option State
CONF ERR	configuration error
CONFTEST	Configuration data in controller in error
CONT ALG	Control Algorithm
CYC SEC	Cycle Time
CYC2 SEC	Cycle Time 2 (Cool)
DEADBAND	Output Relay Deadband
DIG IN 1	Remote Switching 1 selections
DROPOFF	Controller Dropoff Value
E E FAIL	Unable to write to non-volatile memory
END SEG	End Segment Number
FACT CRC	Factory Calibration Cyclic Redundancy test
FAILSAFE	Controller in Failsafe
FILTER 1	Input 1 Filter
FILTER2	Input 2 Filter
FINAL SP	Single Setpoint Final Setpoint
GAIN	Gain
GAIN2	Gain 2

Parameters

IN1 HI	Input 1 High Range Value
IN2 HI	Input 2 High Range Value
IN1 LO	Input 1 Low Range Value
IN2 LO	Input 2 Low Range Value
INP1 RNG	Input Out of Range
INP1FAIL	Two consecutive failures of Input integration
KPG	Process Gain Value
LOCKOUT	Configuration Lockout
LOOPBACK	Local Loop Back
MAN	Lower display automatically indicates output in %.
MAN RSET	Manual Reset
MINorRPM	Reset Units
MSTP	manual step change
OUT HYST	Output Relay Hysteresis
OUT LOLIM	Low Output Limit
OUTHILIM	High Output Limit
OUTLOLIM	Low Output Limit
PARITY	Parity
PBorGAIN	Proportional Band or Gain Units
PID SETS	Tuning Parameter Sets
PROG END	Program Termination State
PROP BD	Proportional Band
PROP BD2	Proportional Band 2
PV LIMIT	Derived PV Out of Range
RAM TEST	RAM test failed
RAMPUNIT	Engineering units for ramp segments
RATE MIN	Rate in Minutes
RATE2MIN	Rate 2 in Minutes
RECYCLES	Number of Program Recycles
RSET MIN	Reset in minutes/repeat
RSET RPM	Reset in repeats/minute
RSET RPM	Reset in repeats/minute
RSET2MIN	Reset 2 in minutes/repeat
RSET2RPM	Reset 2 in repeats/minute
RSP SRC	Remote Setpoint Source
RV LIMIT	Remote Variable Out of Range
SECURITY	Security Code
SEG1RAMP	Segment #1 Ramp Time
SEG1RATE	Segment #1 Rate Time
SHED SP	Shed Setpoint Recall
SHEDMODE	Shed Controller Mode and Output Level
SHEDTIME	Shed Time
SOAK DEV	Guaranteed Soak Positive or Negative Deviation Value
SP CHANG	Setpoint Change Value
SP HILIM	Setpoint High Limit
SP LOLIM	Setpoint Low Limit
SP PROG	Setpoint Ramp/Soak Programming
SP RAMP	Single Setpoint Ramp
SP TRACK	Local Setpoint Tracking
STATE	Program state at program end
STRT SEG	Start Segment Number
SW VALUE	Automatic Switchover Value
TIME MIN	Single Setpoint Ramp Time
UNITS	Communication Units
XMITTER	Transmitter Characterization
XMITTER2	Transmitter Characterization Input 2

References

Publication Title	Publication Number
UDC3000/UDC5000/UDC6000 RS422/485 Communications Option Manual	51-51-25-35
UDC5000 DMCS Communications option Section of the Gateway Manual	82-50-10-24

Section 1 – Overview

1.1 Introduction

Function

The UDC5000 Universal Digital Controller is a microprocessor-based, one or two loop controller that controls a process either manually or automatically.

The controller produces analog outputs based on operator-entered data and one, two, or three isolated loop related analog input signals. Two loops of control allow Internal Cascade Control.

See the block diagrams for:

- One loop of control - Figure 1-2
- Two loops of control - Figure 1-3
- Internal Cascade control - Figure 1-4

Inputs

Two isolated, low-level inputs let you directly connect low-level sensors such as thermocouples, RTD's, or transducers directly to Input 1 or Input 2.

Input 1 to the controller is usually the process variable of the loop. An optional second input can be used as:

- PV Loop 2
- an independent variable to be monitored for alarm purposes only
- as a remote setpoint signal
- for computing the Weighted Average of both inputs
- as the dry bulb input for relative humidity
- connected to a zirconium oxide sensor for measuring Carbon Potential
- Other input algorithms available with the second input are Math options which include Input Summing and Subtracting with or without Ratio and Bias, Feedforward, Mass Flow calculations, or HI/LO Input Select with or without Ratio and Bias.

An optional third input provides a high level, isolated, 4 to 20 mA or 1 to 5 Volts dc signal which can be used as a remote setpoint, process variable, alarm parameter, or feedforward signal, and limited math functions.

Outputs

This universal output controller provides the capability of a single current output, single or dual relay output, or position proportional control.

Continued on next page

Output Algorithms

Depending on how many loops you configure, the UDC5000 is available with various preselected output algorithms including:

- Time Proportional Simplex
- Time Proportional Duplex*,
- Current Proportional,
- Current Proportional Duplex
- Current/Relay Duplex (Relay = Heat or Cool),
- Position Proportional Control*

** Time Proportional Duplex, Position Proportional, and 3 Position Step Control are not available on second loop of control.*

Control Algorithms

The basic characteristics of an automatic controller is its control algorithm - the way it restores the controlled variable to the desired value (setpoint). Depending on the Control output type specified, the controller can be configured for the following control algorithms:

- On/Off control**,
- PID-A Equation
- PID-B Equation
- PD with Manual Reset.
- Three Position Step Control**

Duplex control can be configured for all algorithms except 3 Position Step.

*** ON/OFF and 3 Position Step are not available on the second loop of control.*

Continued on next page

1.1 Introduction, Continued

Options

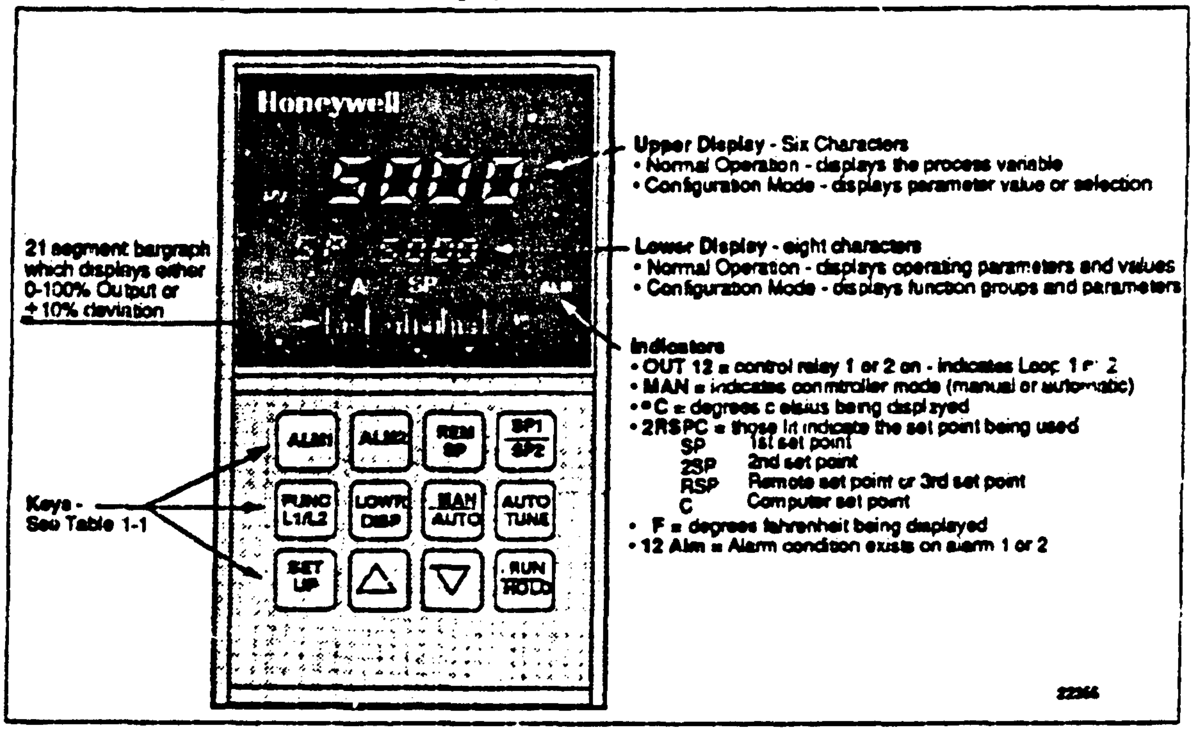
Available options include:

Adaptive Tuning	Continually adjusts the PID tuning parameters in response to Process Variable disturbances and/or Setpoint changes.
Autotune	Automatically calculates and enters into memory, the optimum tuning parameters required for your process. A "Short Tune" procedure lets you obtain approximate tuning constants.
Setpoint Ramp/Soak Programming	Lets you program and store 10 ramp and 10 soak segments to be used as one program or multiple small programs.
Auxiliary Output	Provides a 4 to 20 mA output representing any of six controller parameters for recording or control purposes.
Two Loop Controller	Provides software for two independent loops of control with separate prompts and shared display.
Internal Cascade Control	Uses Loop 2 as the primary loop, with the output of Loop 2 being the Remote Setpoint of Loop 1 (the secondary loop). All output form exist on Loop 1.
2nd Input	Provides a 2nd universal input that can be used as remote setpoint or process variable; or combined with input 1 using the Math Options/Input 2 Algorithms.
Math Options	This option provides various input 2 algorithms. These include Summer/Subtractor, Weighted Average, Multiplier/Divider, Relative Humidity, Carbon Potential, Input High/Low Select, and Feedforward.
Third Input	A high level input which also includes Input 3 algorithm for: - High/Low Select with Input 1 - Summer with Input 1 - Feedforward to either Loop.
Transmitter Power	24Vdc power to supply one or two, 4 to 20mA, 2-wire inputs.
Digital Input	Using either of two remote switch, you can switch on contact closure to any nine configurable modes or parameters.
Communications	Serial communications link integrates with CRT-based RS422/485 or Honeywell's DMCS Distributed systems.
Solid State Relays	One or two SPST solid state contacts rated at 2 amps or 10 amps at 120/240 Volts.
Open Collector Output	Provides one or two open collector outputs rated at 24Vdc/30mA.

1.2 Operator Interface

Displays and Indicators Figure 1-1 shows the operator interface and defines the displays and indicators. The function of the keys is shown in Table 1-1.

Figure 1-1 Operator Interface Displays and Indicators



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Function of keys

Table 1-1 shows each key on the operator interface and defines its function.

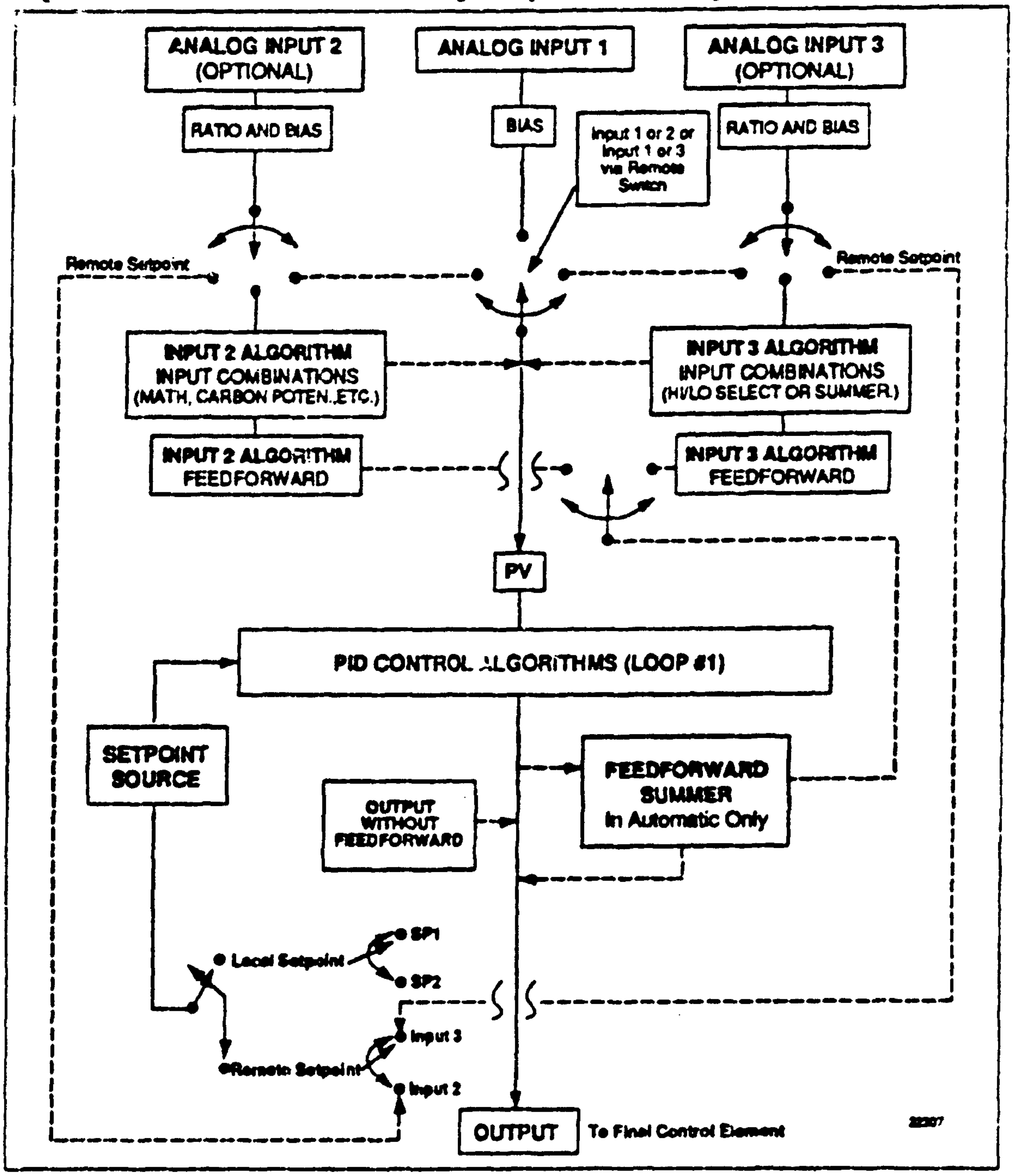
Table 1-1 Function of Keys

Key	Function
ALM 1	• Displays Alarm 1 parameter group.
ALM 2	• Displays Alarm 2 parameter group.
REM SP	• Toggles between local setpoint and remote setpoint or local setpoint 3.
SP1 SP2	• Toggles between Local Setpoint #1 and #2.
FUNC L1/L2	• Used in conjunction with the SET UP key to select the individual functions of a selected Configuration Set Up group. • Used during field calibration procedure. • Also toggles between Loop 1 and Loop 2 display.
LOWR DISP	• Selects any one of the operating parameter to be shown in the lower display. • Used to exit Set Up.
MAN AUTO	• Alternately selects: AUTO Lower display automatically displays setpoint value in engineering units. MAN Lower display automatically indicates output in %.
AUTO TUNE	• Starts the Autotune or Adaptive Tune procedure.
SET UP	• Place the controller in the configuration group select mode. Sequentially displays configuration groups and allows the FUNC key to display individual functions for each group.
▲	• Increases the setpoint, output, or configuration values displayed.
▼	• Decreases the setpoint, output, or configuration values displayed.
RUN HOLD	• Initiated RUN or HOLD of the Setpoint Program option or restores original functions selected in Set Up mode.

1.3 Functional Overviews

Single Loop Controller Figure 1-2 is a Block Diagram of a Single Loop Controller - Loop #1.

Figure 1-2 Functional Overview of a Single Loop Controller - Loop #1



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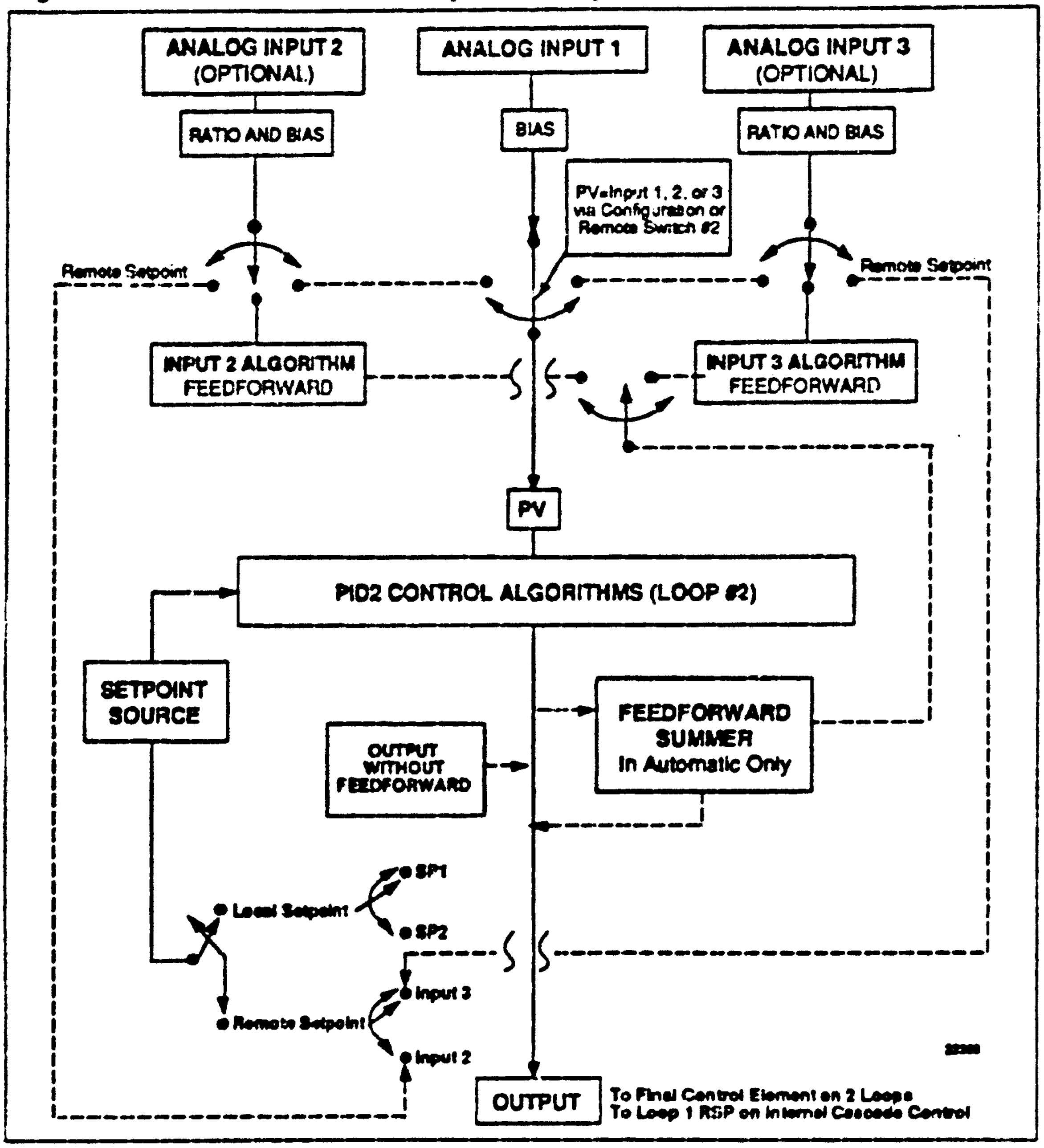
Loop 2 Figure 1-3 is a Block Diagram of Loop 2 of a 2 Loop controller.

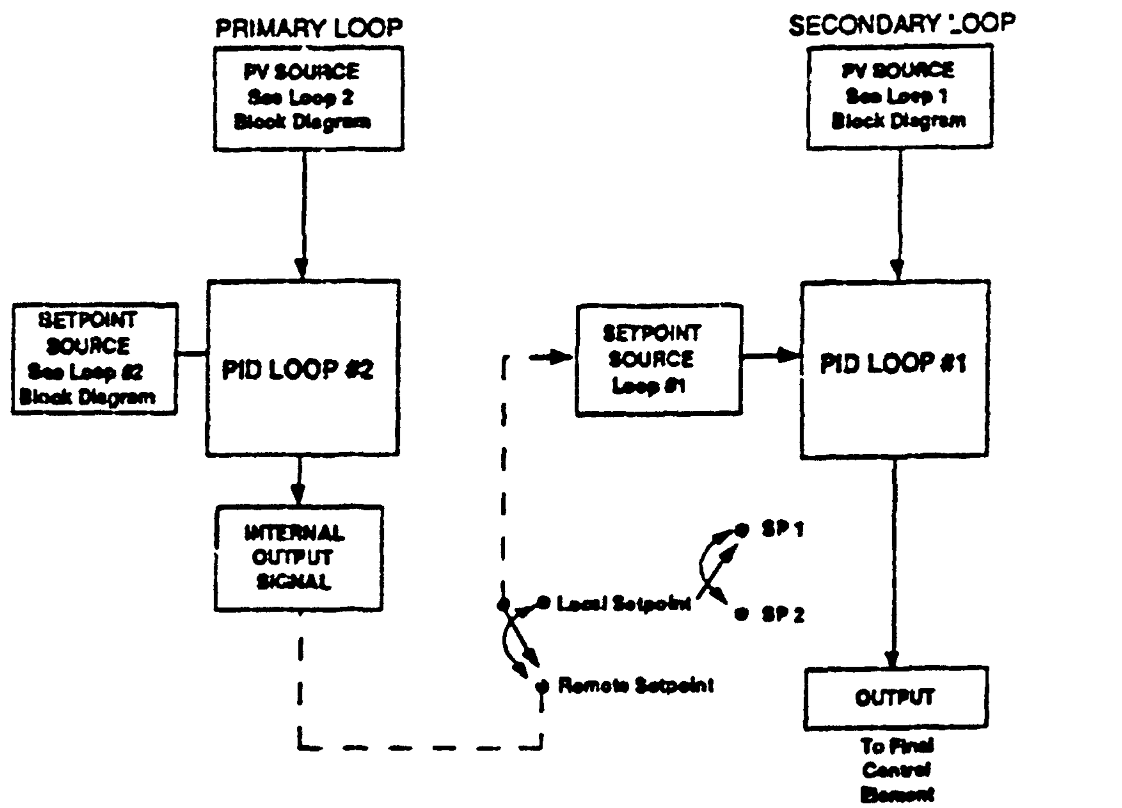
Figure 1-3 Functional Overview of Loop 2 of a 2 Loop Controller



Continued on next page

Internal Cascade Figure 1-4 is a Block Diagram of Internal Cascade for a 2 Loop controller.

Figure 1-4 Functional Overview of Internal Cascade of a 2 Loop Controller



INTERNAL CASCADE RULES

- Loop #2 must be the primary loop.
- Loop #1 must be the secondary (internal or slave) loop because all output forms exist on Loop 1.
- Loop #1 Remote Setpoint is fixed as loop #2 output.

Section 2 – Installation

2.1 Overview

Introduction

Installation of the UDC 5000 Controller consists of mounting and wiring the controller according to the instructions given in this section.
Read the pre-installation information, check the model number interpretation and become familiar with your model selections, then proceed with installation.

What's in this section?

This section contains the following information:

Continued on next page

Pre-installation information

If the controller has not been removed from its shipping carton, inspect the carton for damage and remove the controller. Inspect the unit for any obvious shipping damage and report any damage due to transit to the carrier.

Make sure a bag containing mounting hardware is included in the carton with the controller.

Check that the model number shown on the inside of the case agrees with what you have ordered. Refer to Figure 2-1.

Operating limits

We recommend that you review and adhere to the operating limits listed in Table 2-1 when you install your controller.

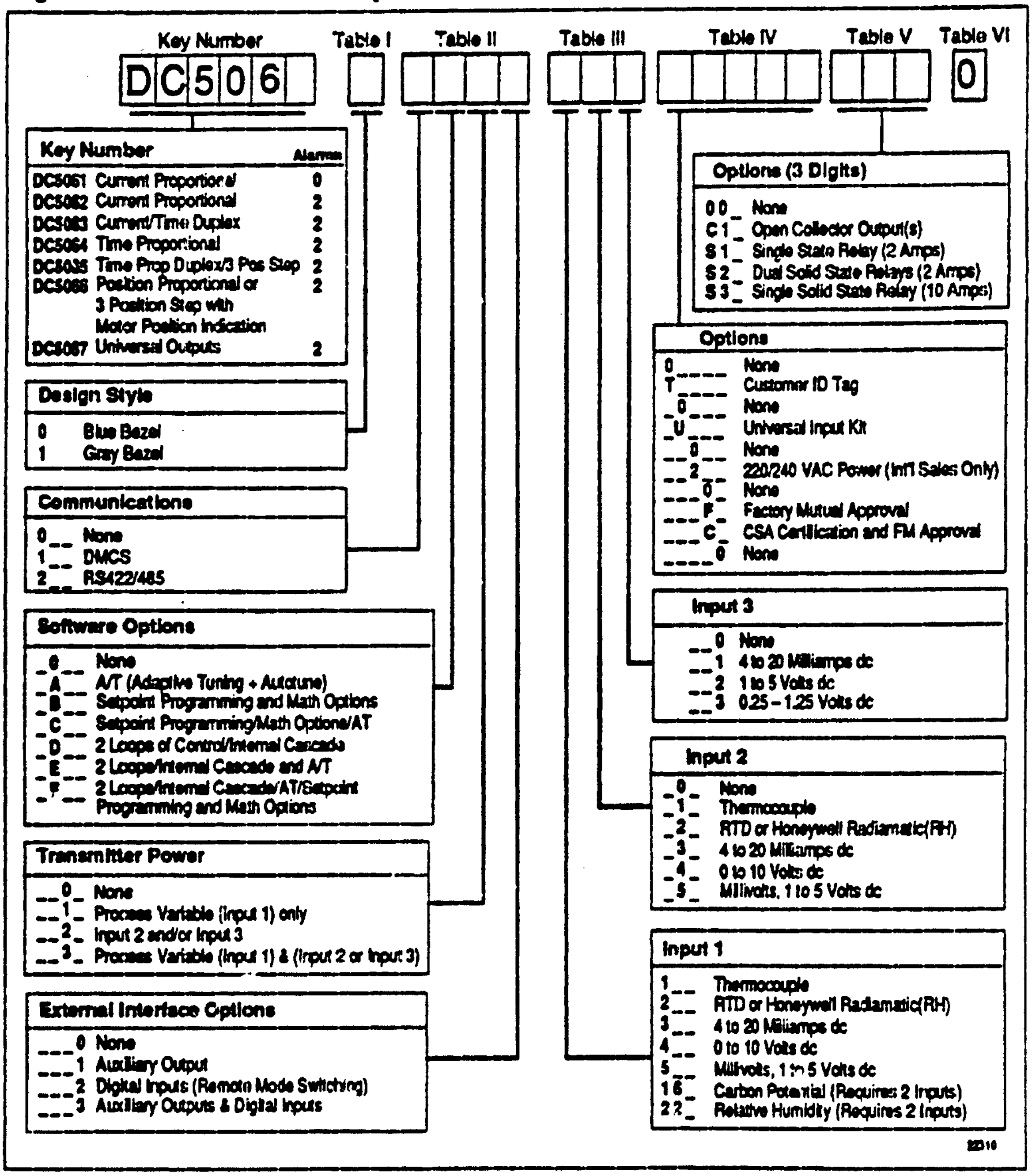
Table 2-1 Operating Limits

Condition	Specifications
Ambient Temperature	32 to 140°F (0 to 60°C)
Relative Humidity	5 to 90% RH at 40°C (104°F)
Vibration Frequency Acceleration	 0 to 200Hz 0.2g
Mechanical Shock Acceleration Duration	 5g 30ms
Power Voltage Frequency(Hz)	 85 to 132 Vac 170 to 264 Vac 48 to 52 58 to 62
Transmitter Supply Voltage (at input terminals)	22 to 26 Vac @ 50mA
Power Consumption	13VA Maximum

2.2 Model Number Interpretation

Model number The model number interpretation is shown in Figure 2-1. Write the model number into the spaces provided and compare it to the model number interpretation. This information will also be useful when you wire your controller.

Figure 2-1 Model Number Interpretation



2.3 Preliminary Installation Checks

Introduction

Before you install the controller, remove the chassis by pulling the front door down, loosening the screw on the front and pulling the chassis out.

Make the preliminary checks listed in Table 2-2 based on the model number of your controller.

Table 2-2 Preliminary Checks

Check	If you have Model	See Page
Operating Voltage Selection	All Models	13
Input Group Type Selection	All Models	14
Optional Input Three, Jumper Selection	DC506X-0-XXXX-XX1 DC506X-0-XXXX-XX2	17
Control Relay Contact Selection	DC5063 DC5064 DC5065 DC5066 DC5067	18
Alarm Relay Contact Selection	DC506X-0-XX1X-XX DC506X-0-XX2X-XX DC506X-0-XX3X-XX	20

Continued on next page

Operating voltage selection

The controller is shipped, configured for use with 120 Volts as shown in Figure 2-2.

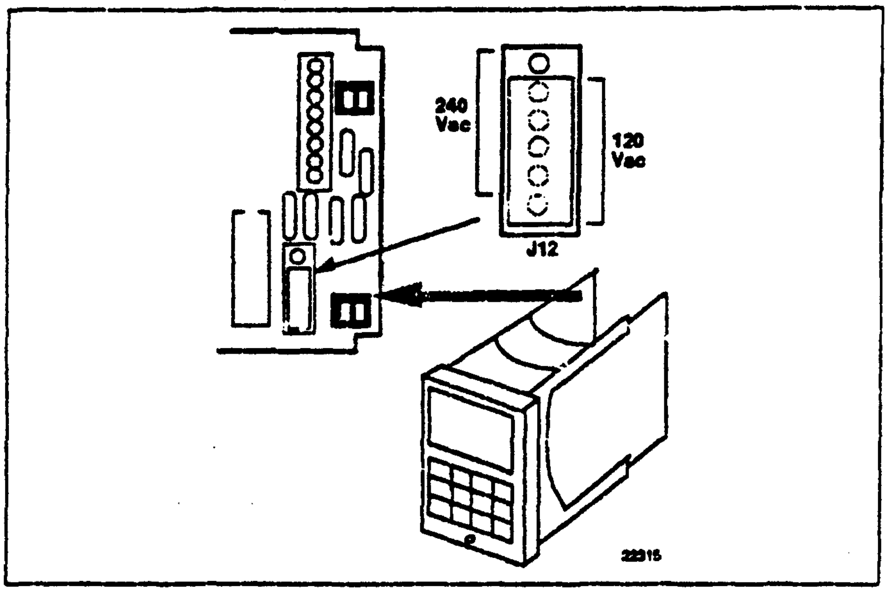
CAUTION **OPERATING A 120 VOLT CONTROLLER AT 240 VOLTS WILL DAMAGE THE UNIT.**

•Make sure that the transformer connection (J12) at the back of the controller is positioned correctly for the operating voltage (120 or 240) that will be used.

•If you want to use 240 Volts, move the connector to the position shown for 240 Volts in Figure 2-2.

•If you want to change the operating frequency from 60Hz to 50Hz, see *Section 3 - Configuration*.

Figure 2-2 Operating Voltage Selection



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Configure the input group type)

The UDC5000 controller will be shipped with Input 1 and 2 set up for the range of 0 to 10 mV Linear range (see Figure 2-1 for model identification).

Your controller is shipped with only the parts needed for your application as selected in the model number. You can change your controller to a different input group if desired.

When you change from some input groups to others, (for example: 4-20 mA to Thermocouple), you must adapt the input circuitry so that it will be compatible with the input signal.

For the following type of actuation sources:
- Thermocouples and RTD
- 0 to 10 Volts
- 4 to 20 Milliamps

you must:
- Install or remove a jumper on the controller printed wiring board depending on the actuation type/range to which you are changing (See "*Dual Jumper for Input 1 and Input 2*").
- Install and/or remove a resistor assembly depending on the actuation type or range to which you are changing (see "*Resistor Assembly*").

Continued on next page

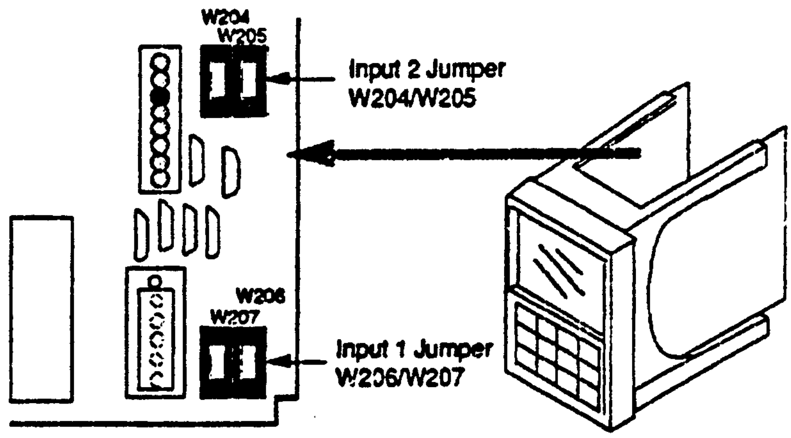
Dual jumper for Input 1 and Input 2

Depending on the type of input actuation or range that you are selecting, install or remove the dual jumper at the desired position on the controller board. Refer to Figure 2-3 and follow the procedure in Table 2-3.

Table 2-3 Installing or Removing Dual Jumper for Input 1 and 2

Step	Action
1	Locate the two dual jumper positions identified as W204/W205 and W206/W207 on the rear of the controller board (see Figure 2-3) ATTENTION The white lines on the top of the jumper must be vertical for proper continuity.
2	Determine which of the two dual jumper positions on the controller board is applicable to the input circuit that you want to change: INPUT NO. 1: Position W206/W207 INPUT NO. 2: Position W204/W205 Refer to Figure 2-3 for jumper selection.
3	Install or remove the jumper(s).

Figure 2-3 Dual Jumper Location



Type of Actuation	Input 1 W206/W207	Input 2 W204/W205
T/C, RTD	Jumper	Jumper
4 to 20 mA (no transmitter power)	None**	None**
All others (transmitter power)	None	None

For example: If you are changing input 2 to a 0 to 10 Volt range, remove the jumper if it appears in the above position, if you are changing to thermocouple or RTD actuation, install the jumper.

** NOTE: If you are changing from 4 to 20 mA with transmitter power, you must disable the transmitter power board. Refer to page 22.

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Continued on next page

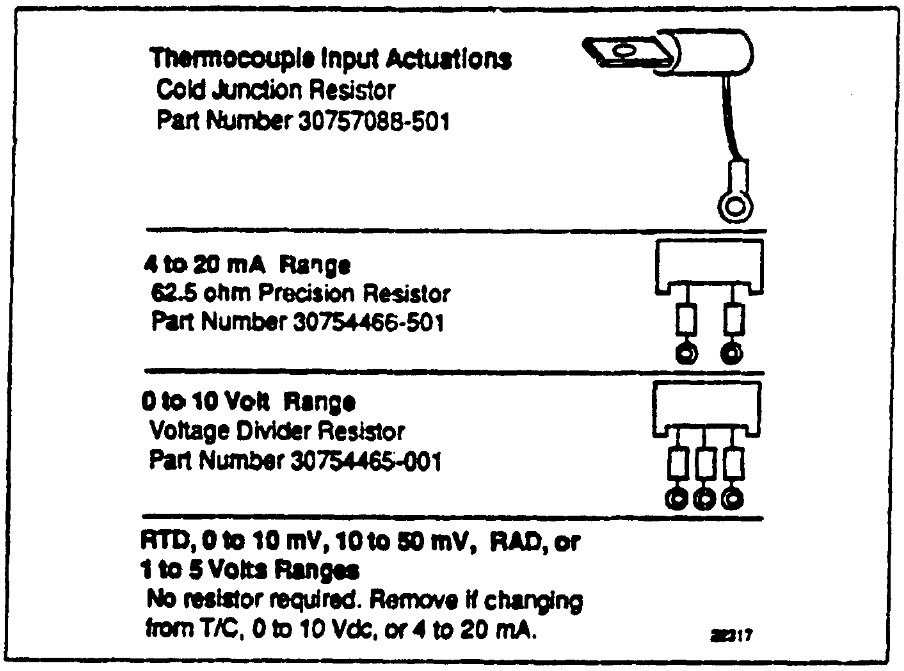
Resistor assembly

You can order a Universal Input Kit (Part Number 30754471-501) from which you can choose the appropriate resistor to install at the appropriate input terminals. Figure 2-4 gives you a graphic view of these resistors and their part number as well as the inputs for which they are used.

Select the appropriate resistor from Figure 2-4 and install it at the appropriate input terminals as shown on the external wiring diagram in Figure 2-13.

ATTENTION When installing a cold junction for a T/C input, remove the "R" screw (terminal 21 or 18 as applicable) from the terminal board, and install the resistor assembly into its place.

Figure 2-4 Resistor Assembly Selection



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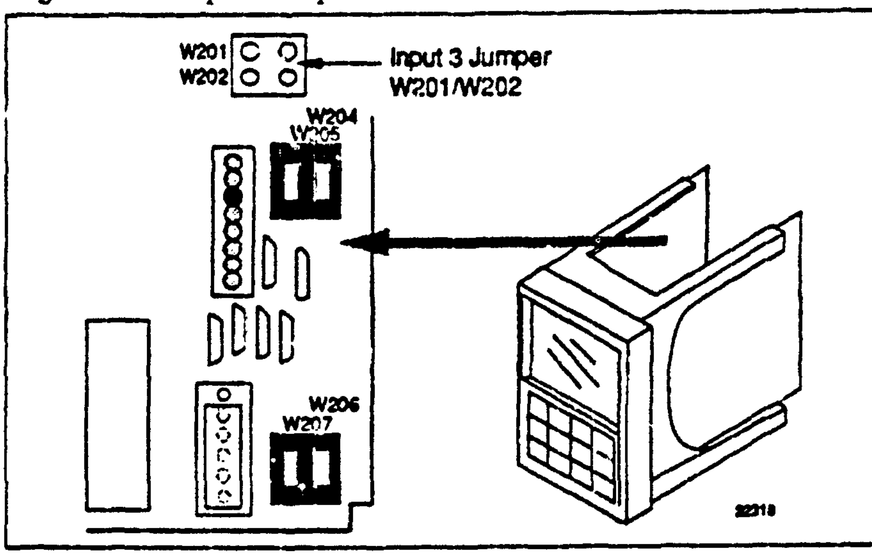
Checking the Input 3 jumper selection

For controllers with the third input option, jumper W201/W202 is the third input selector. Refer to Figure 2-5 for jumper location and place the jumper as follows:

- No Third Input or Position Proportional Output = Jumper Position W201
- Third Input selected = Jumper Position W202

ATTENTION Third Input and Positional Proportional Output are mutually exclusive.

Figure 2-5 Input 3 Jumper Location



Calibrating the position proportional output

Note that the Position Proportional Output or Three Position Step Models (DC5066) must have the output calibrated per Subsection 8.3 - "Position Proportional Output Calibration" to ensure the displayed output (slidewire position) agrees with the actual final control element position.
Model DC5065, Three Position Step Models only, requires that only the motor time be entered (See subsection 8.3, **Full calibration is not required**).

Continued on next page

Checking the control relay contact selection

The controller has been shipped with CONTROL relays configured for **Normally Open** contacts as shown in Figure 2-6 If you want to change the relay action, refer to Figure 2-5 for jumper location and Table 2-4 for Relay Contact information and reposition the jumpers on the controller board for (NC) Normally Closed contacts on the control relay as listed below:

JUMPER POSITION	CONTROL RELAY	RELAY ACTION
W110	#1	N.C.
W111	#1	N.O.
W112	#2	N.C.
W113	#2	N.O.

ATTENTION Control relays operate in the standard control mode i.e. Energized when output state is ON.

Table 2-4 Control Relay Contact Information

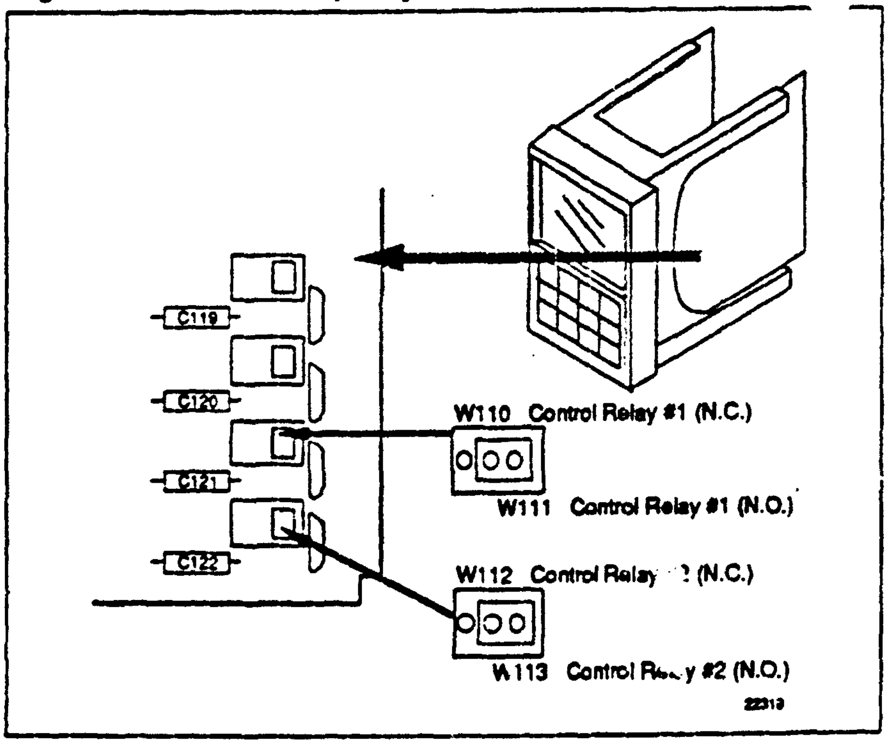
UNIT POWER	CONTROL RELAY JUMPER	CONTROL RELAY CONTACT	#1 OR #2 OUTPUT INDICATOR STATUS
OFF	N.O.	Open	Off
	N.C.	Closed	
ON	N.O	Open	Off
		Closed	On
	N.C	Closed	Off
		Open	On

CAUTION When alarm or control relay are used to drive AC-powered customer solid state relays, be sure that the external relay are functioning properly. *See sub-section 2.4 - Caution Note or Section 9 - Troubleshooting* if the external relays are not being activated.

Continued on next page

Checking the control relay contact selection, continued

Figure 2-6 Control Relay Jumper Placement



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Checking the Alarm relay contact selection

The controller has been shipped with ALARM relays configured for Normally Closed contacts as shown in Figure 2-7. If you want to change the relay action, refer to Figure 2-7 for jumper location and Table 2-5 for Alarm Relay Contact information and reposition the jumpers on the controller board for (NO) Normally Open contacts on the alarm relay as listed below:

JUMPER POSITION	ALARM RELAY	RELAY ACTION
W106	#2	N.O.
W107	#2	N.C.
W108	#1	N.O.
W109	#1	N.C.

ATTENTION Alarm relays are designed to operate in a failsafe mode i.e. De-energized during alarm state. This results in alarm actuation when power is OFF or when initially applied, until the unit completes self-diagnostics. If power is lost to the unit, the alarms will function.

Table 2-5 Alarm Relay Contact Information

UNIT POWER	ALARM RELAY JUMPER	VARIABLE NOT IN ALARM		VARIABLE IN ALARM STATE	
		RELAY CONTACT	INDICATORS	RELAY CONTACT	INDICATORS
Off	N.O.	Open	Off	Open	Off
	N.C.	Closed		Closed	
On	N.O.	Closed	Off	Open	On
	N.C.	Open		Closed	

CAUTION When alarm or control relay are used to drive AC-powered customer solid state relays, be sure that the external relay are functioning properly. See *Subsection 2.4 - Caution Note* or *Section 9 - Troubleshooting* if the external relays are not being activated.

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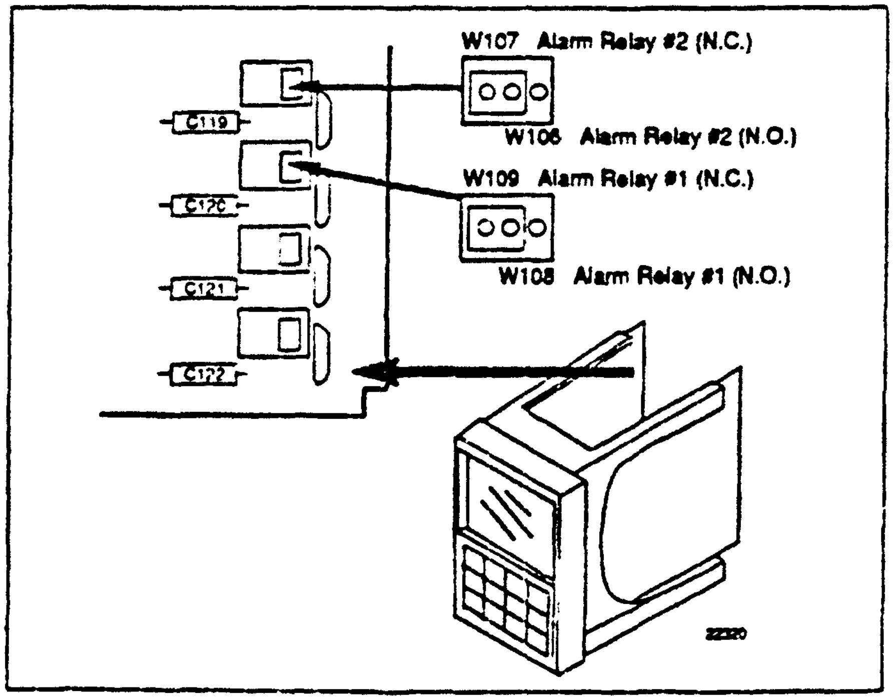
Checking the Alarm relay contact selection, continued

Figure 2-7 Alarm Relay Jumper Placement



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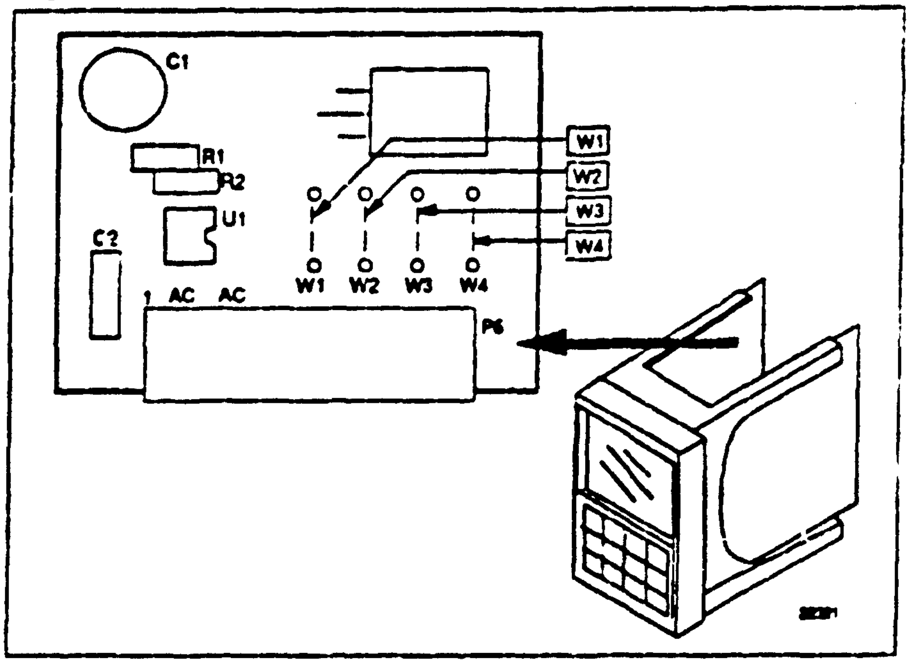
Checking the transmitter power selection

The transmitter power board, which is plugged into the controller board, is configured at the factory in accordance with your model number selection (None, Input 1, Input 2, input 3, or all).
If you want to change the transmitter power configuration, install the cowbell jumpers, supplied with the power board, across the appropriate pins on the power board as indicated below and shown in Figure 2-8.

TRANSMITTER POWER	JUMPER POSITIONS
Input 1 only	W3 and W4
Input 2 or Input 3	W1 and W2
Input 1, 2, or 3	W1, W2, W3, W4
Disable Inputs	Remove all jumpers

Figure 2-8 Transmitter Power Jumper Positions



2.4 Alarm and Control Relay Caution Note

Alarm and Control Relay

CAUTION The alarm and control relay output suppression (snubber) circuitry can be extremely critical when controlling processes and maintaining plant safety. The UDC 5000 Universal Digital Controller is shipped with a board-mounted R-C suppression circuit. Its purpose is to protect the relay contacts from arcing due to high energy spikes. These spikes could occur when driving highly inductive loads and fast cycle-time processes. However, in certain AC-powered, external solid state relays with very high input impedance, an undesirable leakage current can flow in the R-C suppression circuit and cause a voltage across the external load. This prevents deactivation of your external device (such as Solid State relay) even though our display and internal relay are functioning correctly.

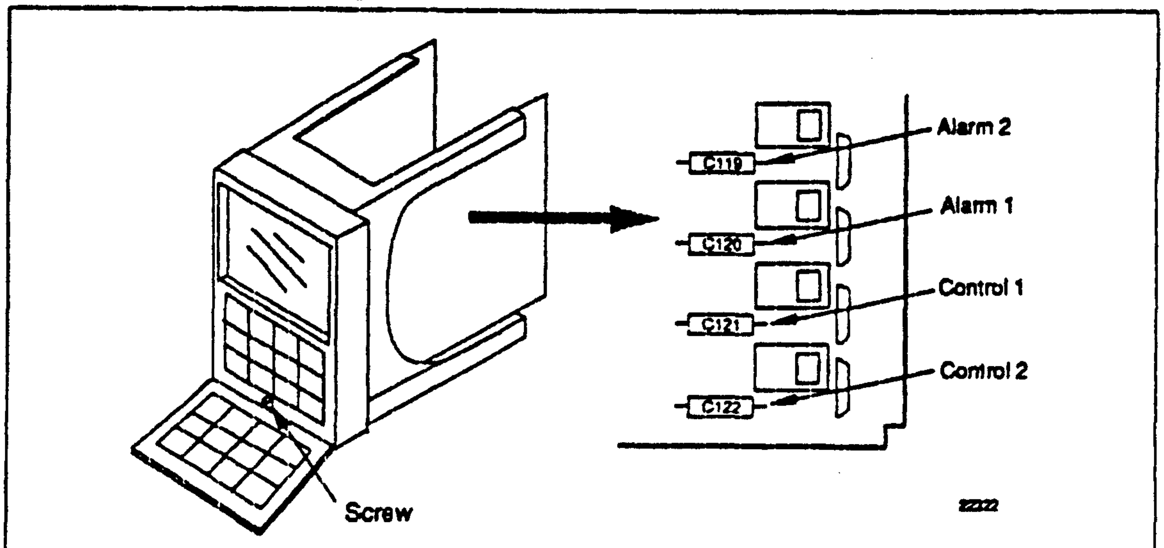
The fix, as shown in Figure 2-9 below, is to open the correct R-C circuit by cutting one of the capacitor leads. This is acceptable because if the above problem occurred, the suppression circuit was not needed. Opening the circuit eliminates any leakage current flow and allows the external relay to function normally.

Refer to Figure 2-9 and follow the procedure in Table 2-6 to make the fix.

Table 2-6 Procedure to Open the R-C Circuit

Step	Action
1	Pull the front door down, loosen the screw on the front, and pull the chassis out of the case.
2	Open the desired circuit by cutting the appropriate capacitor lead (see Figure 2-9).
3	Return the chassis to the case.

Figure 2-9 R-C Circuit Capacitor Location



2.5 Mounting

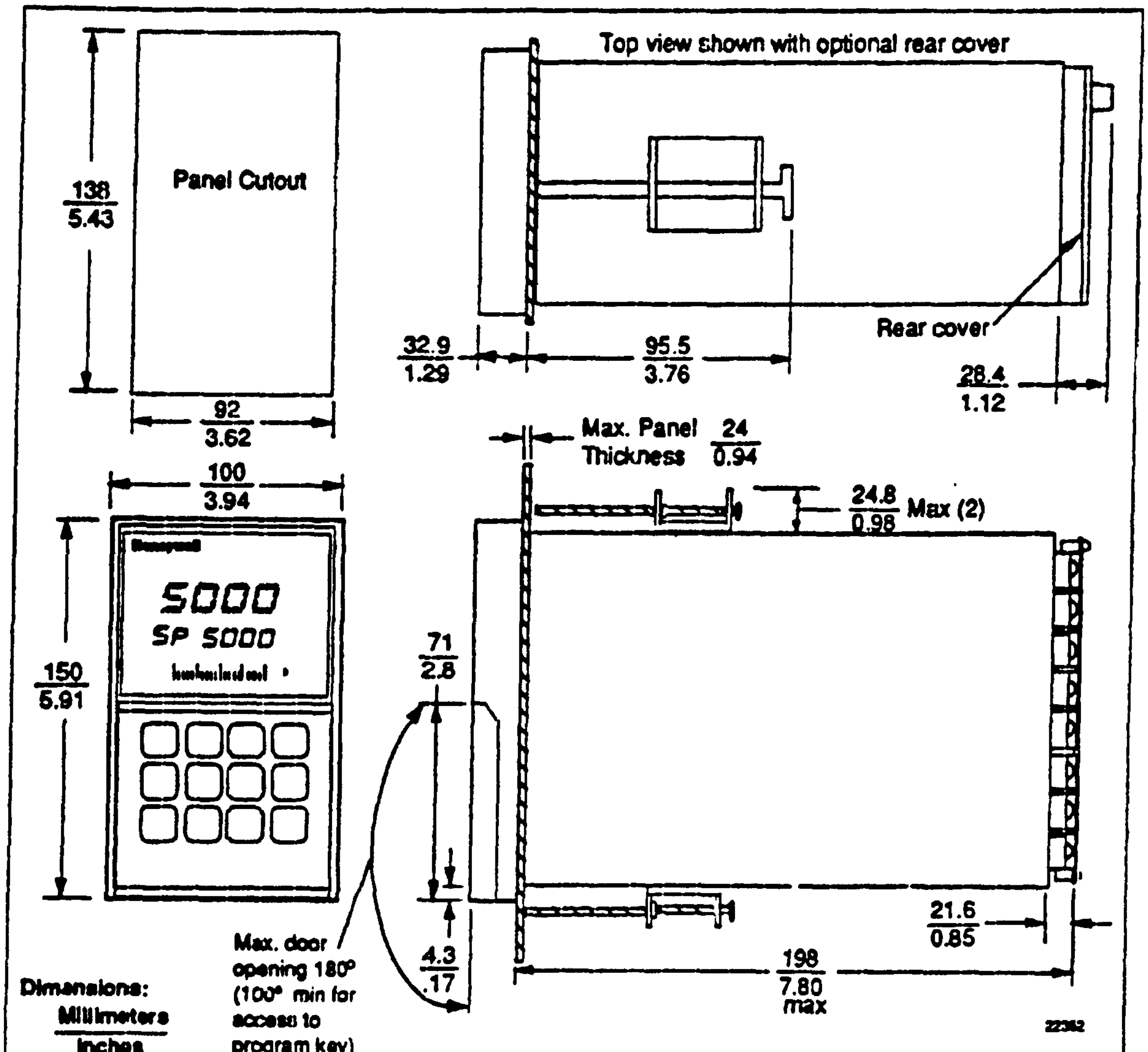
Physical considerations The controller can be mounted on either a vertical or tilted panel using the mounting kit supplied. Adequate access space must be available at the back of the panel for installation and servicing activities.

The overall dimensions and panel cutout requirements for mounting the controller are shown in Figure 2-10.

The controller's mounting enclosure must be grounded according to CSA standard C22.2 No. 0.4 or Factory Mutual Class No. 3820 paragraph 6.1.5.

Overall dimensions Figure 2-10 shows the overall dimensions for mounting the controller.

Figure 2-10 Dimensions



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Note Model Number

Before mounting the controller, refer to the nameplate on the outside of the case and make a note of the model number. It will help later when selecting the proper wiring configuration.

Mounting procedure

Follow the procedure In Table 2-7 below to mount the controller.

Table 2-7 Mounting Procedure

Step	Action
1	Mark and cut out the controller hole in the panel according to the dimension information in Figure 2-10. There is no minimum horizontal spacing defined. Vertical spacing must be provided for access to the mounting kit brackets.
2	Loosen the screw on the front of the controller located under the door. Pull the chassis out of the case.
3	Orient the case properly and slide it through the panel hole from the front.
4	Remove the mounting kit (#30755050-001)from the shipping container, and install the kit as follows: • Install the screws into the threaded holes of the clips. • Insert the prongs of the clips into the two holes in the top and bottom of the case. • Tighten both screws to secure the case against the panel. • Carefully slide the chassis assembly into the case, press to close and tighten the screw. Replace the screw cover.
5	In addition to the mounting kit, a Rear Terminal Cover Kit (#30755494-001) is also provided. Also available is an adapter kit for DIN 43700 Panel Cutout (5.43 in. x 5.43 in.) to fit Dialatrol, Barber-Colemen 560, and Leeds and Northrup E Max cutout, Part Number 30752640-001.

2.6 Wiring

Taking electrical noise precautions

Electrical noise is composed of unabated electrical signals which produce undesirable effects in measurements and control circuits.

Digital equipment is especially sensitive to the effects of electrical noise. Your controller has built-in circuits to reduce the effect of electrical noise from various sources. If there is a need to further reduce these effects:

- Separate External Wiring - separate connecting wires into bundles (see Table 2-8) and route the individual bundles through separate conduits or metal trays.
- Use Suppression Devices - for additional noise protection, you may want to add suppression devices at the external source. Appropriate suppression devices are commercially available.

NOTE For additional noise information, refer to *Appendix B*.

Permissible wire bundling

Table 2-8 shows which wire functions should be bundled together.

Table 2-8 Permissible Wiring Bundling

Bundle No.	Wire Functions
1	• Line power wiring • Earth ground wiring • Control relay output wiring • Line voltage alarm wiring
2	Analog signal wire, such as: • Input signal wire (thermocouple, 4 to 20 mA, etc.) • 4-20mA output signal wiring • Slidewire feedback circuit wiring • Digital input signals • Communications
3	• Low voltage alarm relay output wiring • Low voltage wiring to solid state type control circuits

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Identify your wiring requirements

To determine the appropriate diagrams for wiring your controller, refer to the model number interpretation in this section. The model number of the controller contains selection codes that identify the Input type, Output type, Standard Input Ranges, Number of Alarms, Software Options, and Optional selections. The model number of the controller can be found on the outside of the case and or chassis.

Wiring the controller

Using the information contained in the model number, select the appropriate wiring diagrams from the figures listed below and wire the controller accordingly.

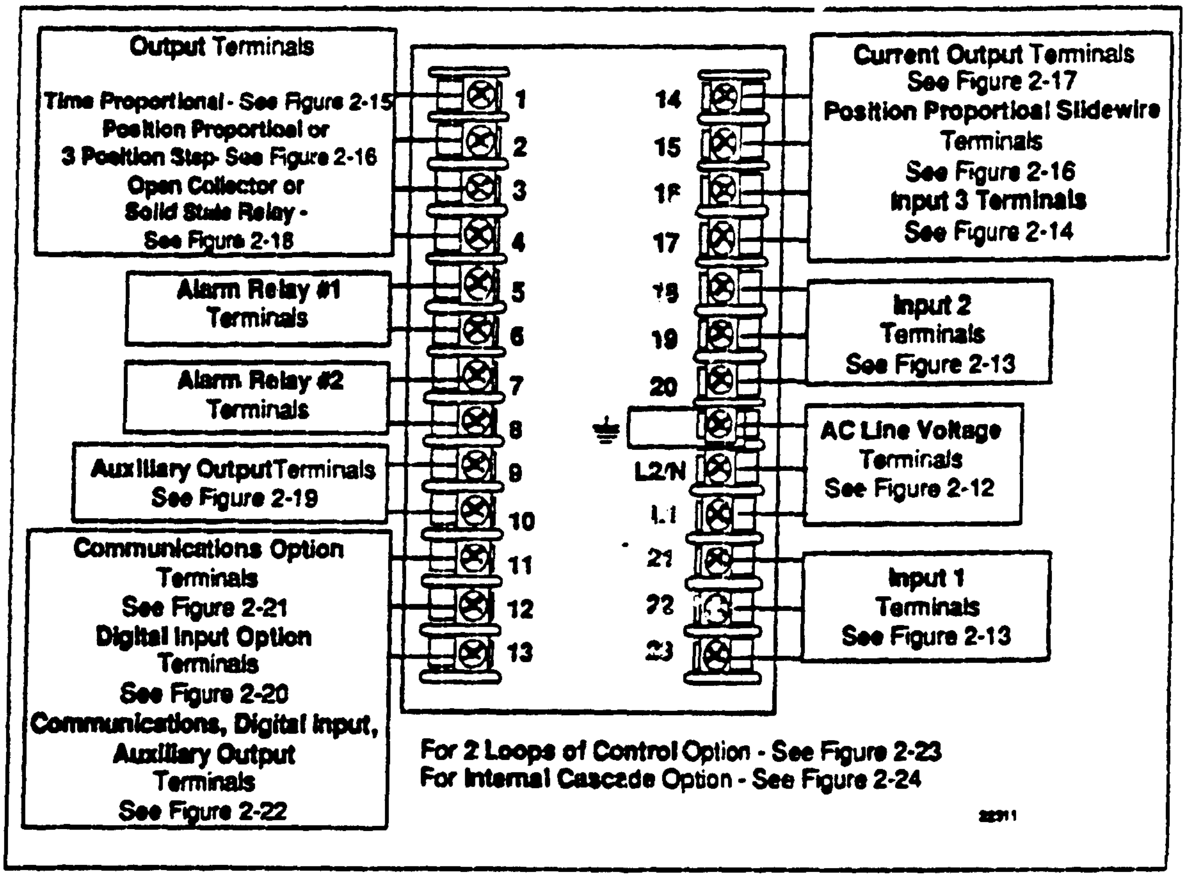
Wiring Requirements	Figure
Composite Wiring Diagram	2-11
AC Line Power	2-12
Inputs #1 and #2	2-13
Input #3	2-14
Time Proportional Output	2-15
Position Proportional Output	2-16
Current Proportional Output	2-17
Open Collector or Solid State Relay Output	2-18
Auxiliary Output	2-19
Digital Input Option	2-20
Communications Option	2-21
Communications and Digital Input with Auxiliary Output	2-22
2 Loops of Control	2-23
Internal Cascade	2-24

2.7 Wiring Diagrams

Composite wiring diagram

Figure 2-11 is a composite wiring diagram of the UDC5000 controller. It identifies the terminal designations and their functions. Refer to the individual diagrams listed to wire the controller according to your requirements.

Figure 2-11 Composite Wiring Diagram



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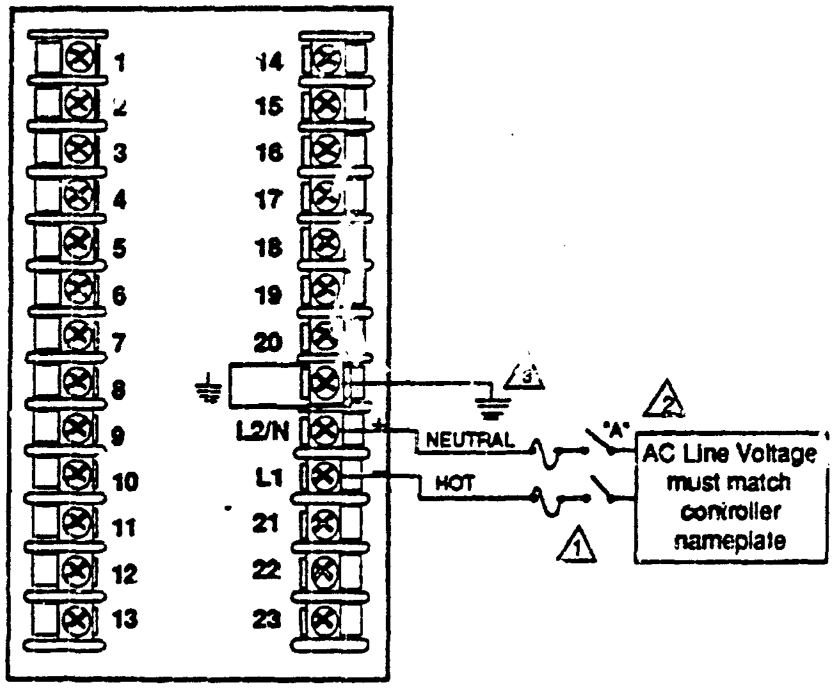
Line voltage wiring Figure 2-12 shows the wiring connections for the line voltage.

Figure 2-12 Line Voltage Wiring



⚠1 External fuse or circuit breakers must be1/2 Amp-250Vac for 120/240 Vac operation.

⚠2 If power service has grounded neutral, connect lead "A" to neutral and omit the fuse in the neutral lead.

⚠3 Ground separately and directly to earth ground using 12 gauge stranded wire.

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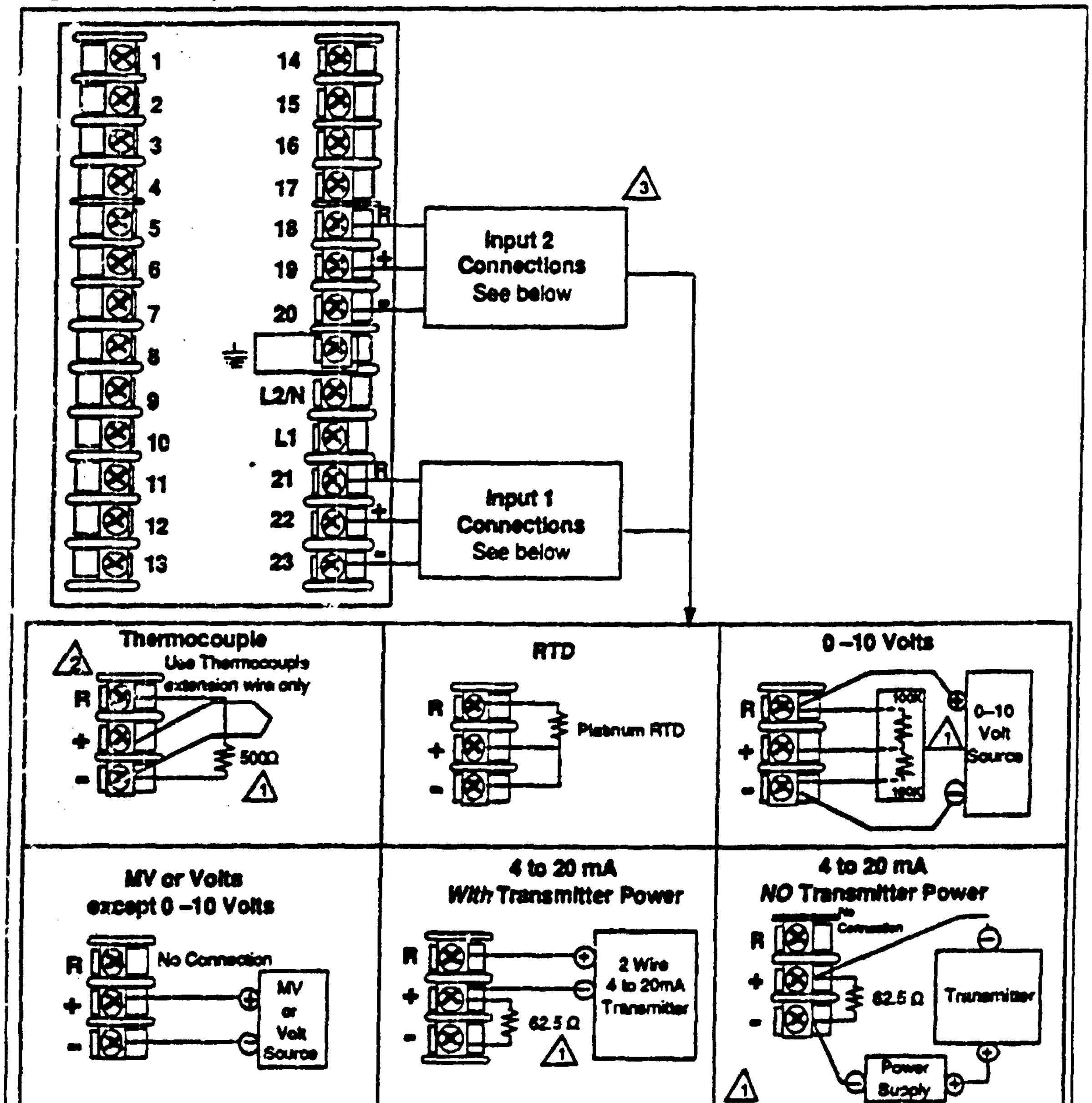
Input 1 and 2 connections

Figure 2-13 shows the wiring connections for Input #1 and #2

Figure 2-13 Input 1 and 2 Connections



⚠1 The 62.5 Ω load resistor for 4–20mA or the Voltage divider for 0–10 Volts or the 500 Ohm C/J compensation resistor are supplied with the controller when the input is specified. These items must be installed when you wire the controller before startup.

⚠2 When installing the cold junction for a T/C input, remove the screw from "R" terminal and install the C/J assembly, connect tang to "–" terminal.

⚠3 For Relative Humidity Option, use Input 2 as the Dry Bulb Input.
For Carbon Potential Option, use Input 2 as the Carbon Probe Input.

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Optional Input 3 Figure 2-14 shows the wiring connections for Optional Input 3.

Figure 2-14 Optional Input 3 Connections

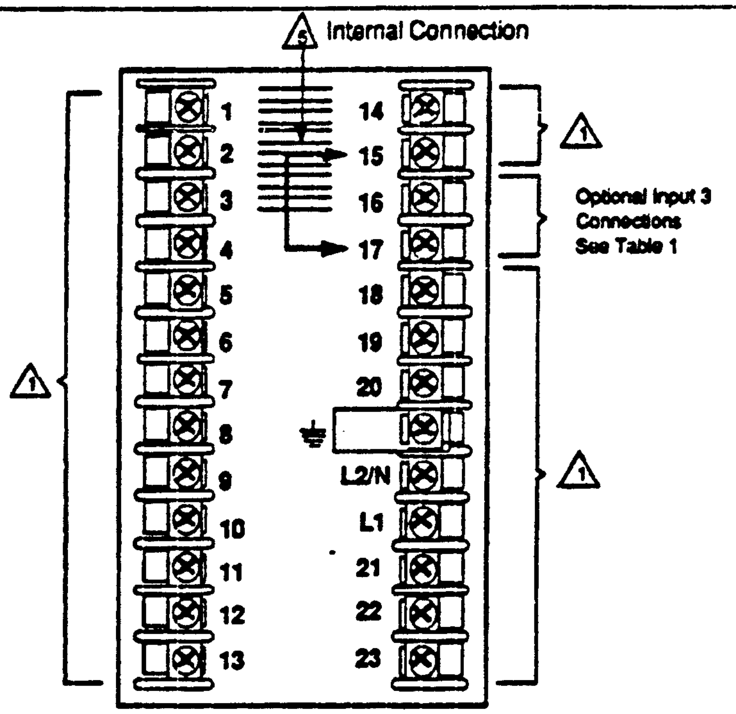
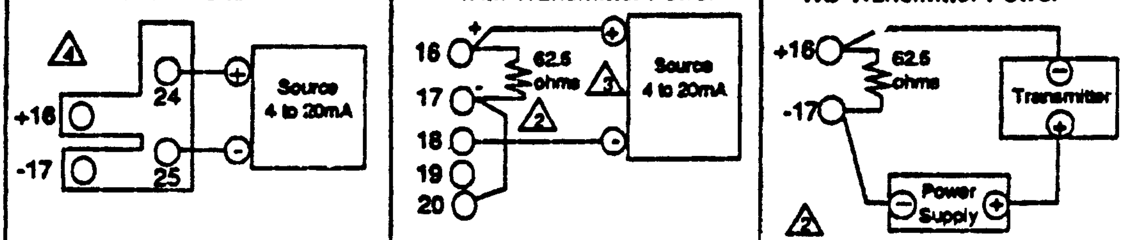


Table 1

1 to 5 Volts	4 to 20 mA *With* Transmitter Power	4 to 20 mA *NO* Transmitter Power



1. See appropriate output wiring for connections.
2. Honeywell supplied 4 to 20 mA resistor, P/N 30754466-501.
3. Transmitter power for the third input is supplied from the second input, terminals #18 and #20. Therefore, when the third input has transmitter power, the second input, third input, and current output are not electrically isolated from each other.
4. Honeywell supplied 1 to 5 Volt printed wiring assembly, P/N 30755946-501.
5. The third input and the current output are not electrically isolated from each other. The negative terminal of the current output (#15) and the negative terminal of the third input (#17) are at the same potential.

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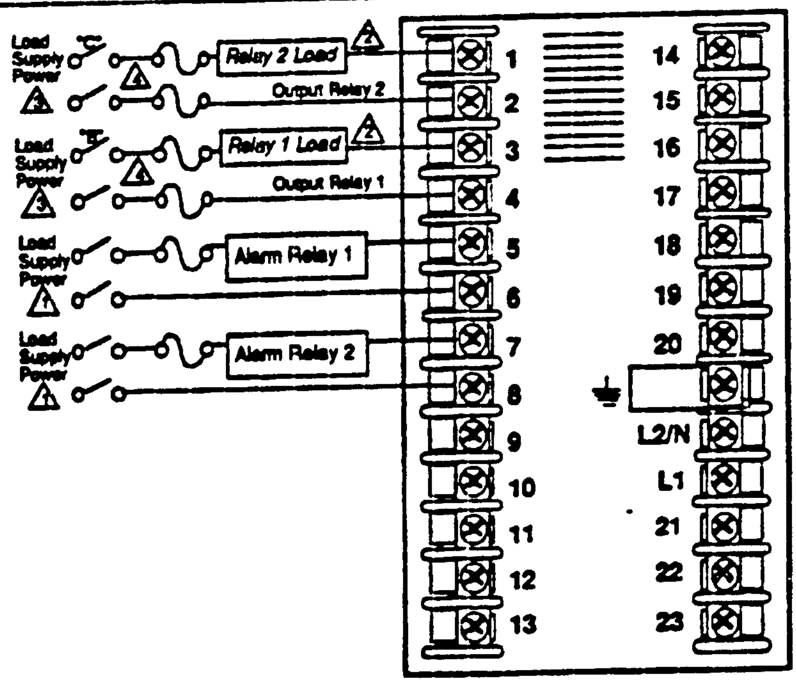
Relay (Time Proportional) Output

Figure 2-15 shows the Output and Alarm wiring connections for models with Relay (Time Proportional) Output (Single Loop or Loop 1).

For Control and Alarm Relay Contact Information, see Tables 2-4 and 2-5.

Figure 2-15 Relay (Time Proportional) Output Connections (Single Loop or Loop 1)



1. UDCs are shipped with alarm relays having normally closed contacts configured. A N.O. or N.C. contact is selectable by means of a jumper on the controller board. See installation section for details. Each alarm is a SPDT relay rated at 5A for 120V or 240V.
2. UDCs are shipped with control relays having normally open contacts configured. A N.O. or N.C. contact is selectable by means of a jumper on the controller board. See installation section for details. Each output is a SPDT relay rated at 50VA for 120V or 240V with maximum in rush factor of 10. Resistive ratings are 7A for 120 or 240V.
3. Voltage must match load nameplate data.
4. If power supply has ground neutral, connect leads "B" and "C" to neutral and omit fuses in neutral legs.

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Position Proportional Output or 3 Position Step

Figure 2-16 shows the Output and Alarm wiring connections for models with Position Proportional Output or 3 Position Step

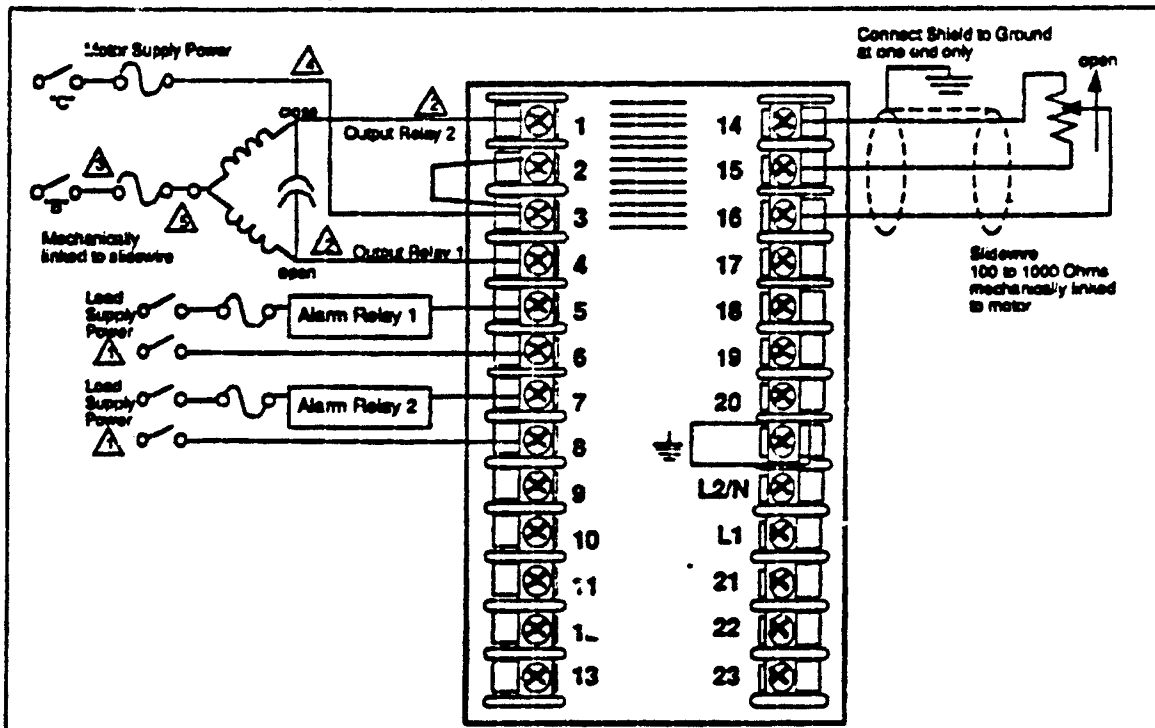
For Control and Alarm Relay Contact information, see Tables 2-4 and 2-5.

Calibration

Position Proportional Output or *Three Position Step* models must have the output calibrated after installation (see *Section 8—Position Proportional Output Calibration*) to ensure that the displayed output (slidewire position) agrees with the actual final control element position.

Three Position Step models only require that the motor time be entered. Full calibration is not required.

Figure 2-16 Position Proportional Output or 3 Position Step (Single Loop or Loop 1)



⚠1 UDCs are shipped with alarm relays having normally closed contacts configured. A N.O. or N.C. contact is selectable by means of a jumper on the controller board. See installation section for details. Each alarm is a SPDT relay rated at 5A for 120V or 240V.

⚠2 UDCs are shipped with control relays having normally open contacts configured. A N.O. or N.C. contact is selectable by means of a jumper on the controller board. See installation section for details. Each output is a SPDT relay rated at 50VA for 120V or 240V with maximum in rush factor of 10. Resistive ratings are 7A for 120 or 240V.

⚠3 If power supply has ground neutral, connect leads "B" and "C" to neutral and omit fuses in neutral legs.

⚠4 Voltage must match load nameplate data.

⚠5 Electrical noise suppression may be required. For additional wiring recommendations, refer to Appendix B "How to Apply Digital Instrumentation in Severe Electrical Noise Environments."

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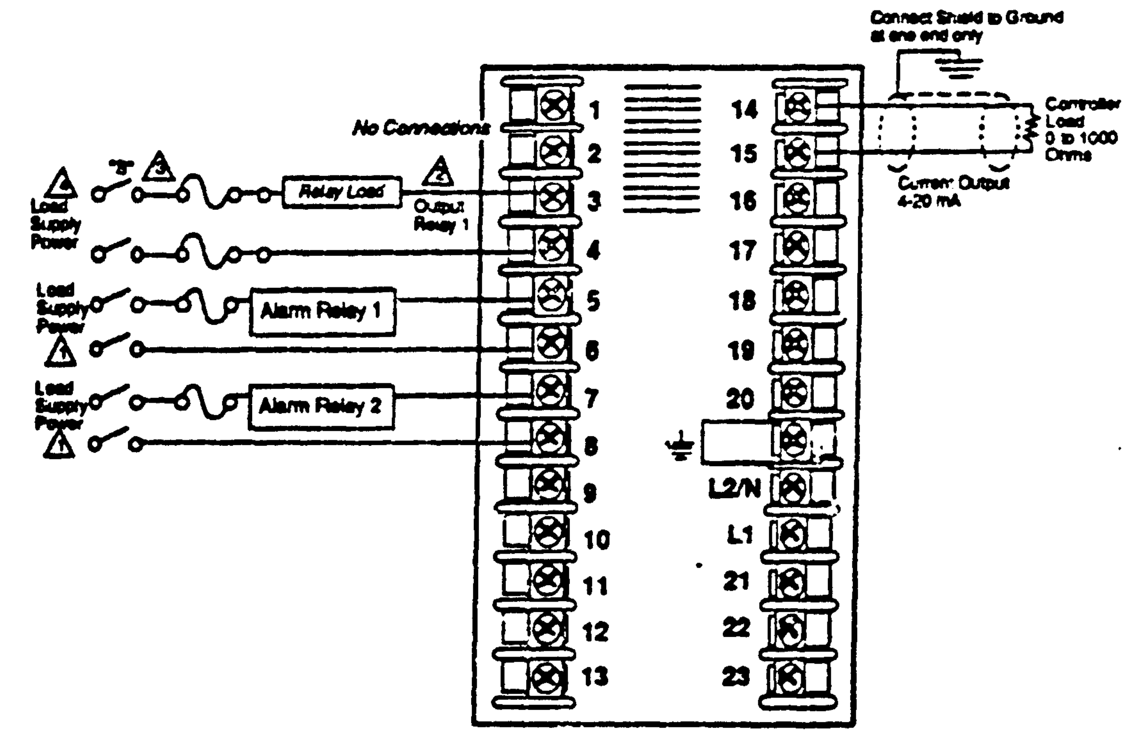
Current proportional output

Figure 2-17 shows the wiring connections for Current Proportional Output (Single Loop or Loop 1).

Figure 2-17 Current Proportional Output Connections



⚠1 UDCs are shipped with alarm relays having normally closed contacts configured. A N.O. or N.C. contact is selectable by means of a jumper on the controller board. See installation section for details. Each alarm is a SPDT relay rated at 5A for 120V or 240V.

⚠2 UDCs are shipped with control relays having normally open contacts configured. A N.O. or N.C. contact is selectable by means of a jumper on the controller board. See installation section for details. Each output is a SPDT relay rated at 50VA for 120V or 240V with maximum in rush factor of 10. Resistive ratings are 7A for 120 or 240V.

⚠3 If power supply has ground neutral, connect leads "B" and "C" to neutral and omit fuses in neutral legs.

⚠4 Voltage must match load nameplate data.

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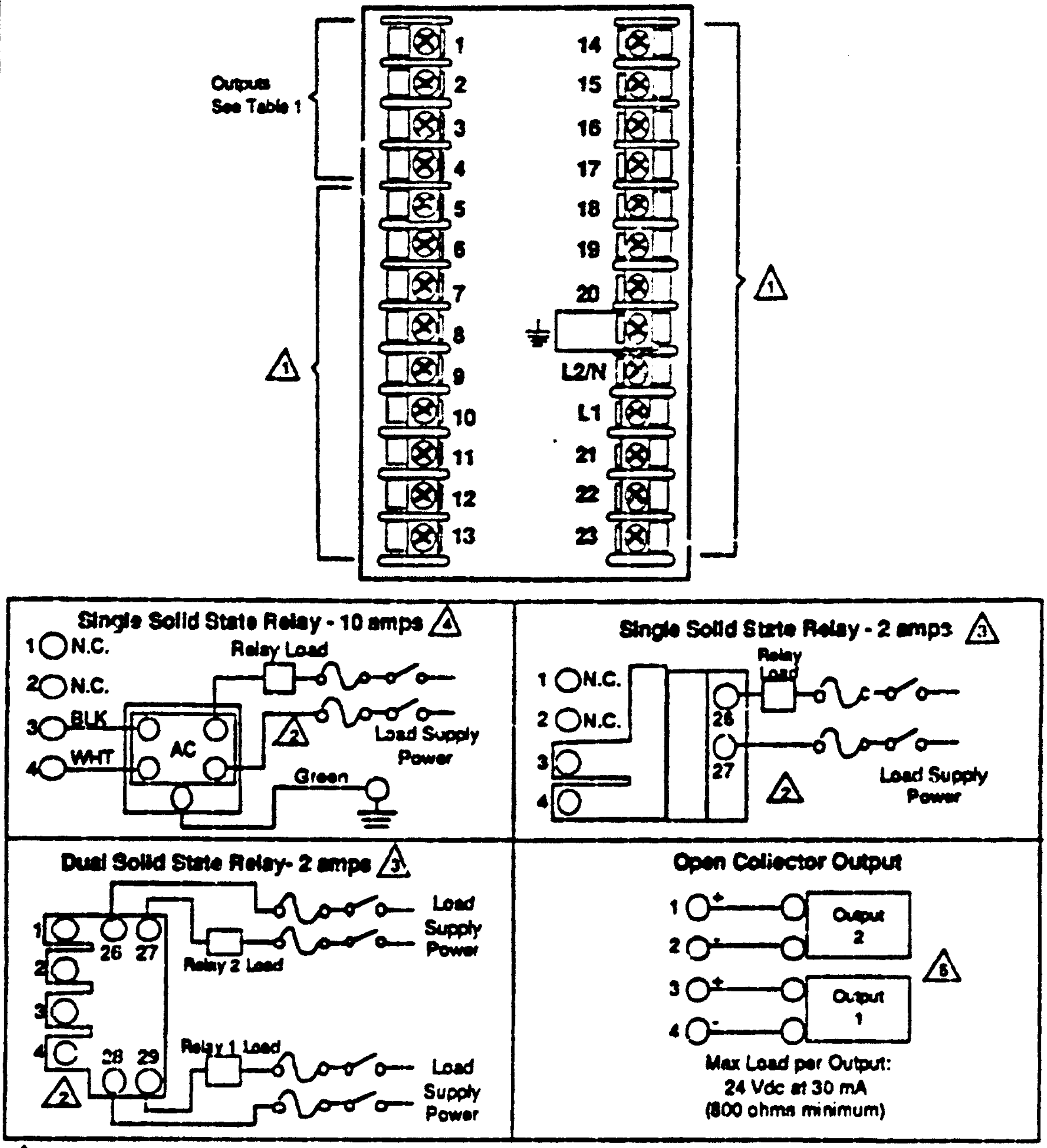
Open Collector or Solid State Relay Output

Figure 2-18 shows the wiring connections for Open Collector or Solid State Relay Output.

Figure 2-18 Open Collector or Solid State Relay Output Connections



1. See appropriate output wiring for connections.
2. Single and Dual Solid State relays are Honeywell supplied.
3. These Solid State Relays are rated at 3 amps at 25°C/77°F derated linearly to 2 amps at 55°C/131°F.
4. These Solid State Relays are rated at 15 amps at 25°C/77°F derated linearly to 10 amps at 55°C/131°F.
5. WARNING Open collector outputs are internally powered. Connecting an external supply will damage the controller.

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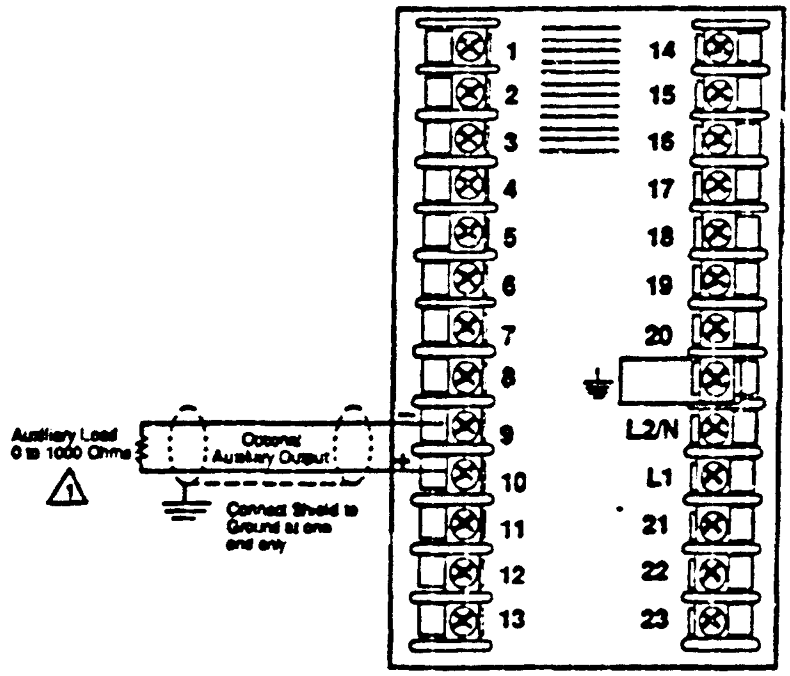
Auxiliary Output Figure 2-19 shows the wiring connections for an Auxiliary Output.

Figure 2-19 Auxiliary Output Connections



⚠1 Auxiliary Output does not use these terminals when Communications and Remote Mode switching are present. Refer to Figure 2-22.

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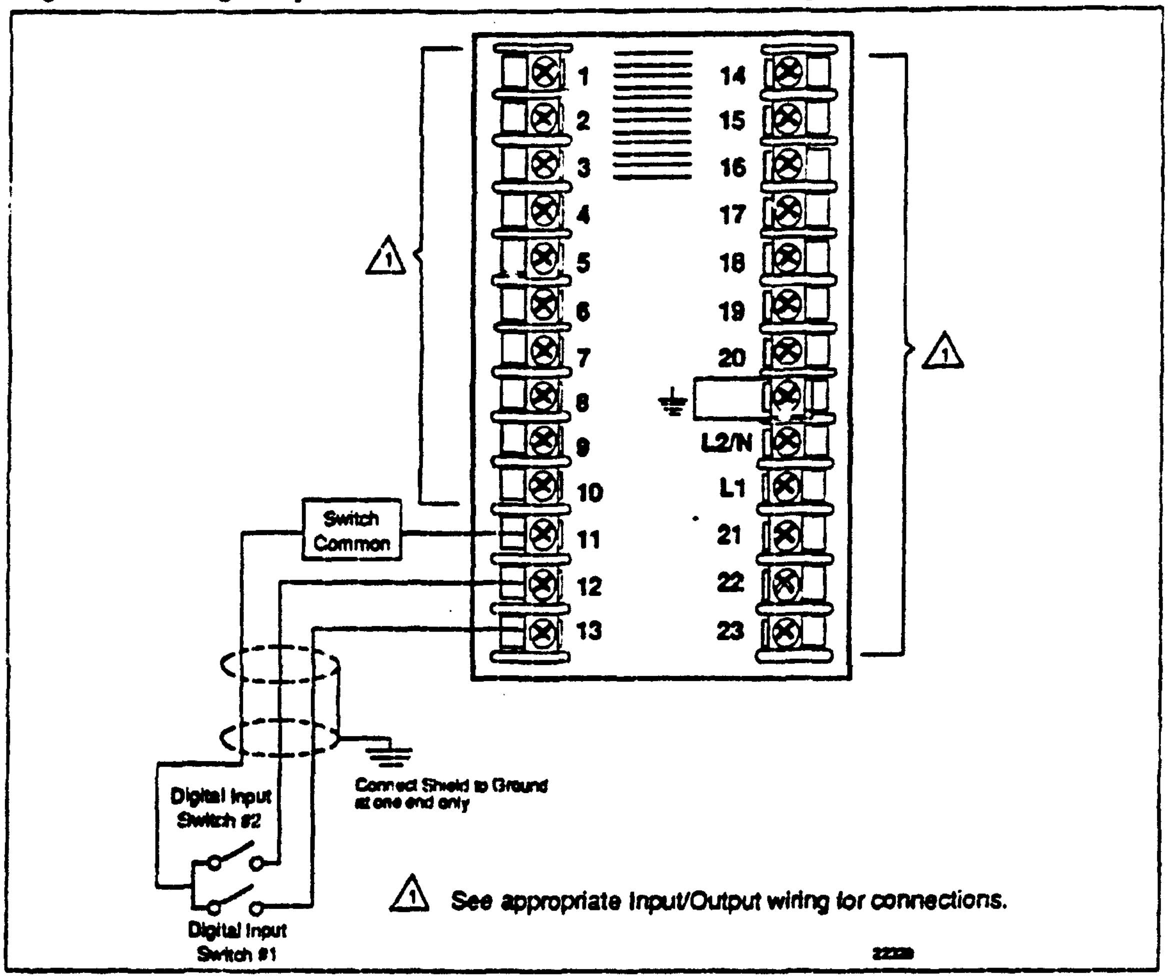
Digital Inputs

Figure 2-20 shows the wiring connections for Digital Inputs (without Communications Option).

Figure 2-20 Digital Input Connections (without Communications Option)



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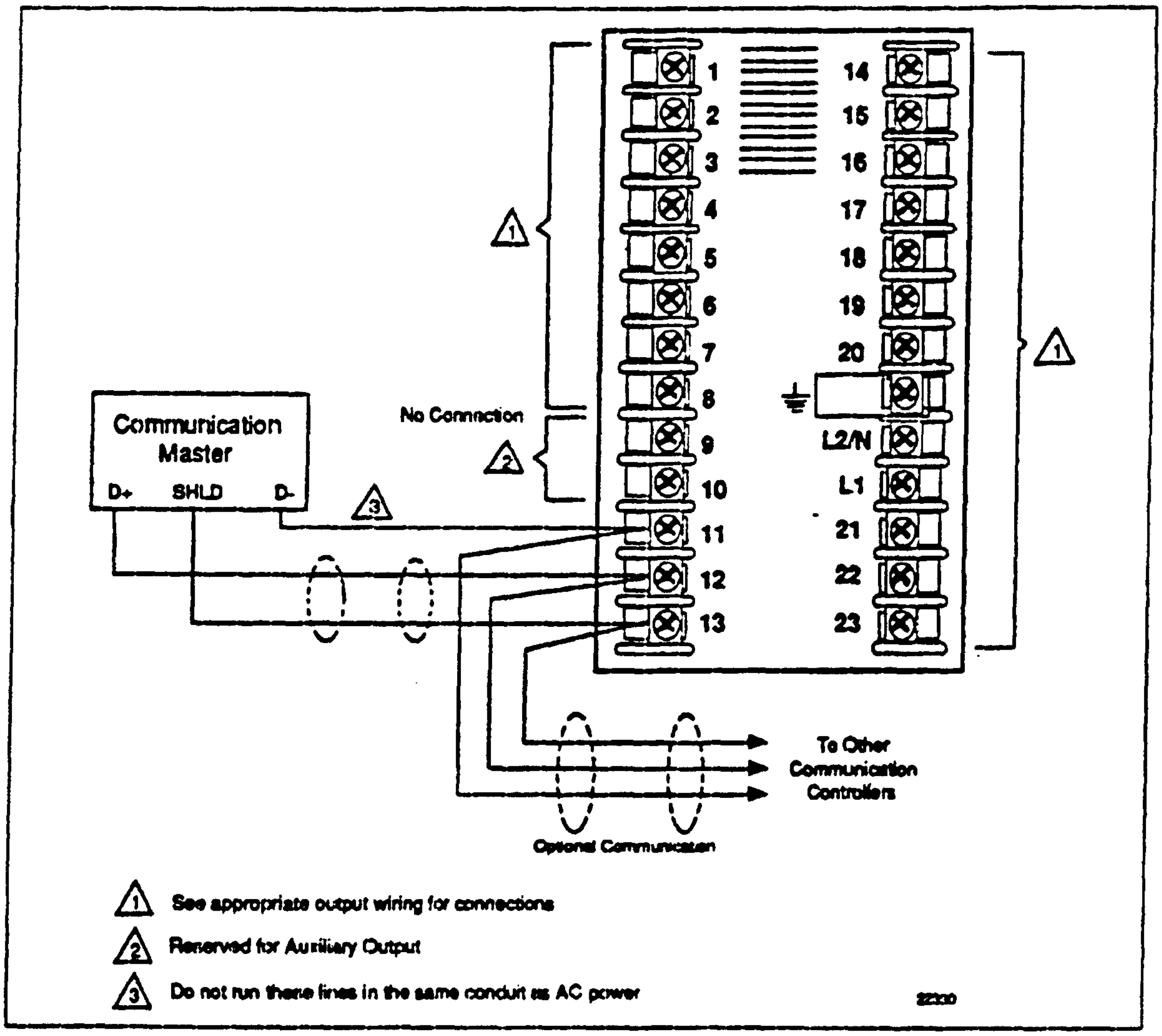
Communications option connections

There are two types of Communications option available:
- RS422/485 - also refer to Document # 51-51-25-35
- DMCS - also refer to Document # 82-50-10-26

Figure 2-21 shows the wiring connections for the Communications Option (without Digital Input Option).

Figure 2-21 Communications Option Connections (without Digital Input Option)



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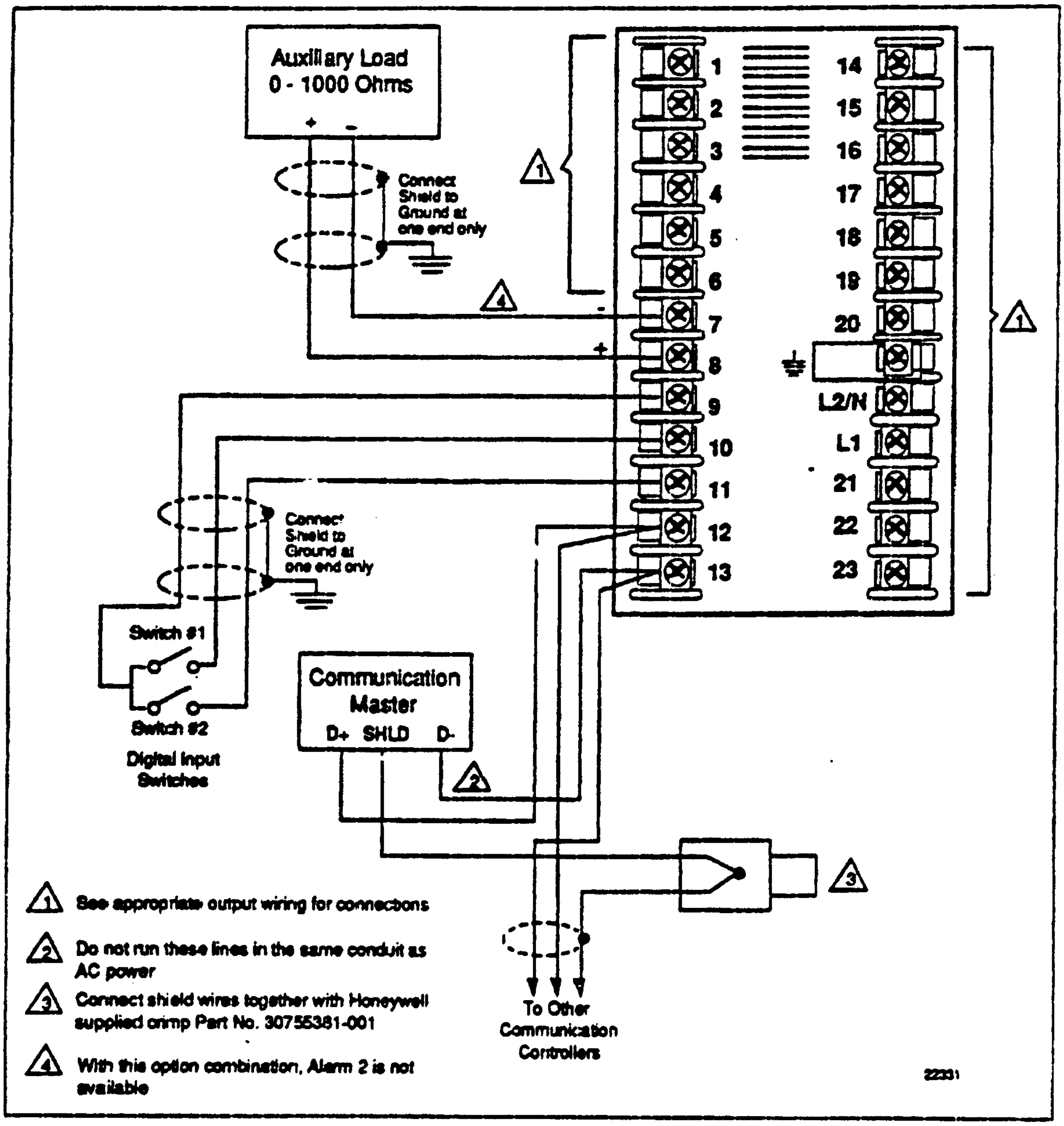
Communications and Digital Inputs with Auxiliary Output

Figure 2-22 shows the wiring connections for Communications, Digital Input, and Auxiliary Output.

Figure 2-22 Communications, Digital Input, and Auxiliary Output Connections



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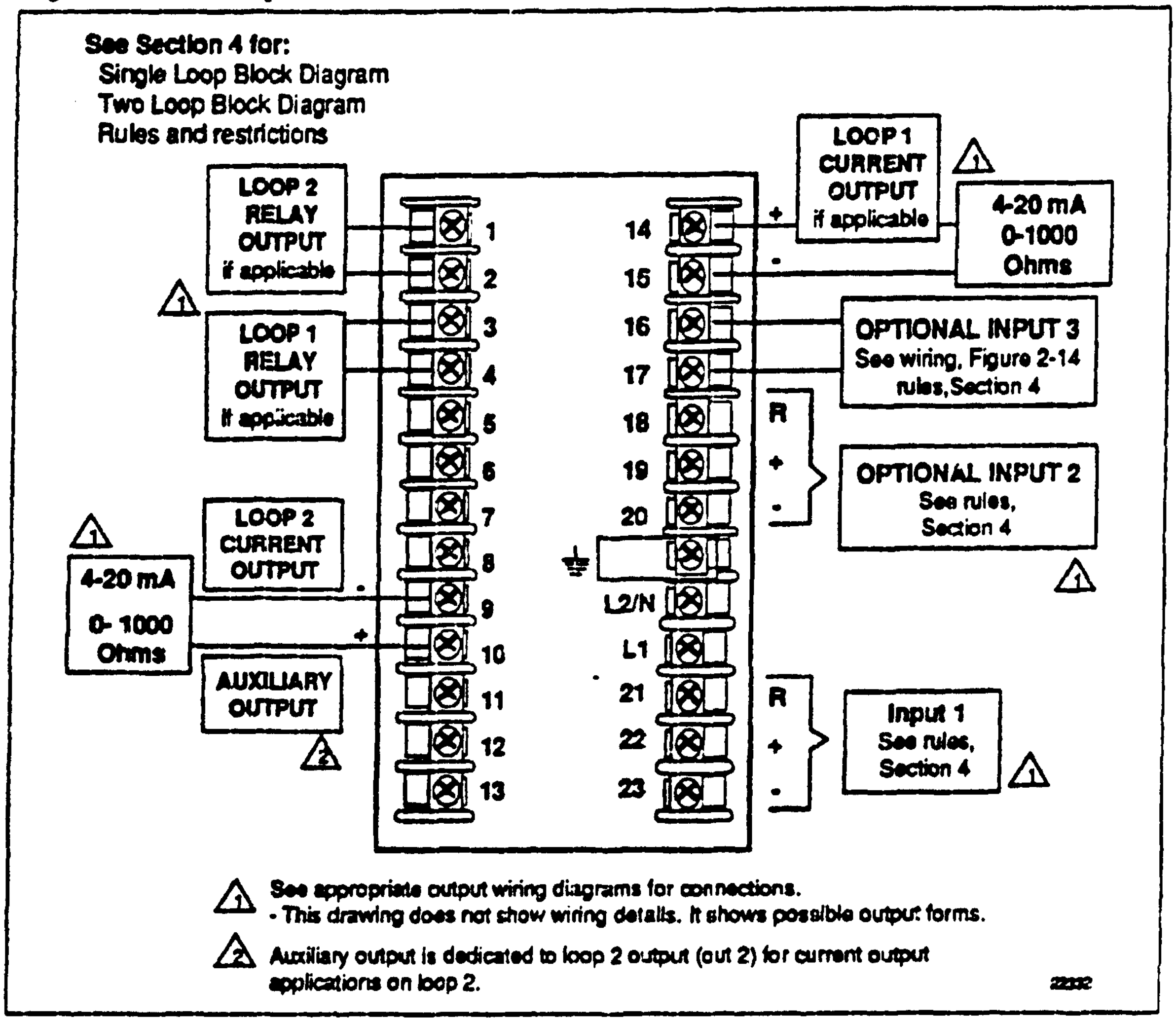
2 Loops of Control Figure 2-23 shows the wiring connections for 2 Loops of Control.

Figure 2-23 2 Loops of Control Connections



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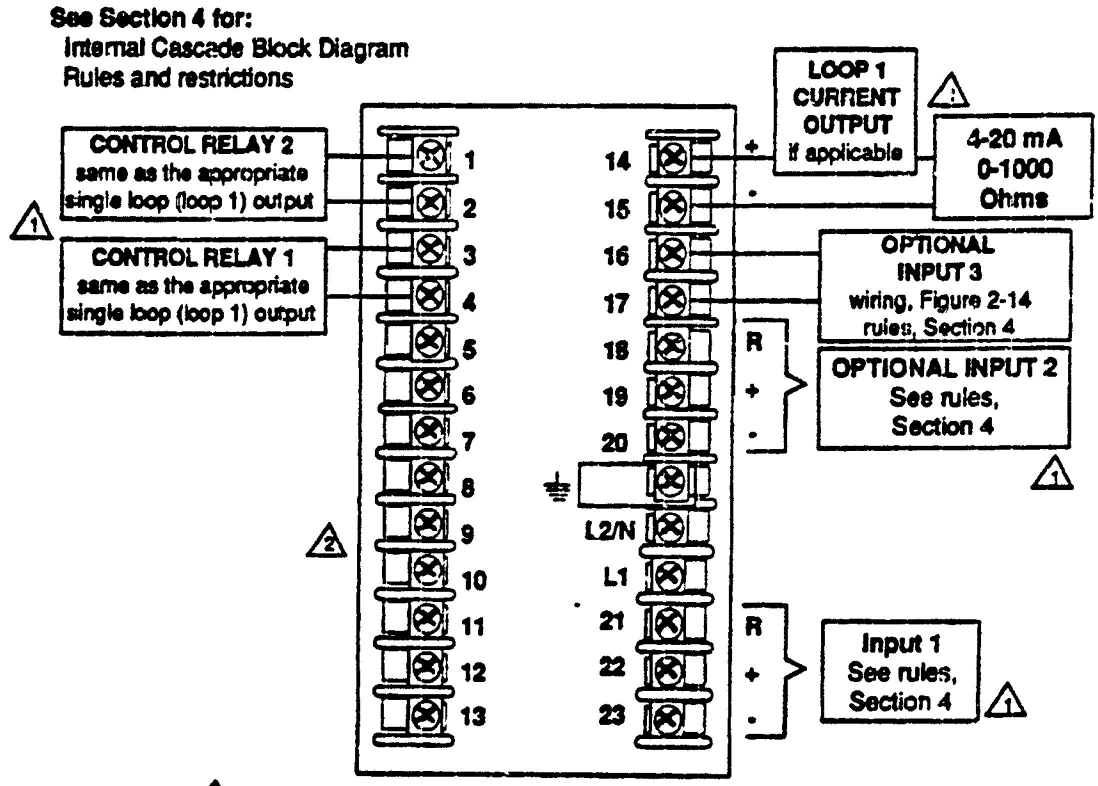
Internal Cascade

Figure 2-24 shows the wiring connections for Internal Cascade Control connections.

Figure 2-24 Internal Cascade Control Connections



1 See appropriate output wiring diagrams for connections.
- This drawing does not show wiring details. It shows possible output forms.

2 Primary controller output (Loop 2) is internally configured to the Remote Setpoint of the secondary controller (Loop 1).

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Section 3 – Configuration

3.1 Overview

Introduction

Configuration is a dedicated operation where you use straightforward keystroke sequences to select and establish (configure) pertinent control data best suited for your application.

What's in this section?

The table below lists the topics that are covered in this section.

Prompts

To assist you in the configuration process, there are prompts that appear in the upper and lower displays. These prompts let you know what group of configuration data (Set Up prompts) you are working with and also, the specific parameters (Function prompts) associated with each group.

Figure 3-1 shows you an overview of the prompt hierarchy.
As you will see, the configuration data is divided into 15 main Set Up groups plus prompts for calibration and prompts that show the status of the continuous background tests that are being performed.

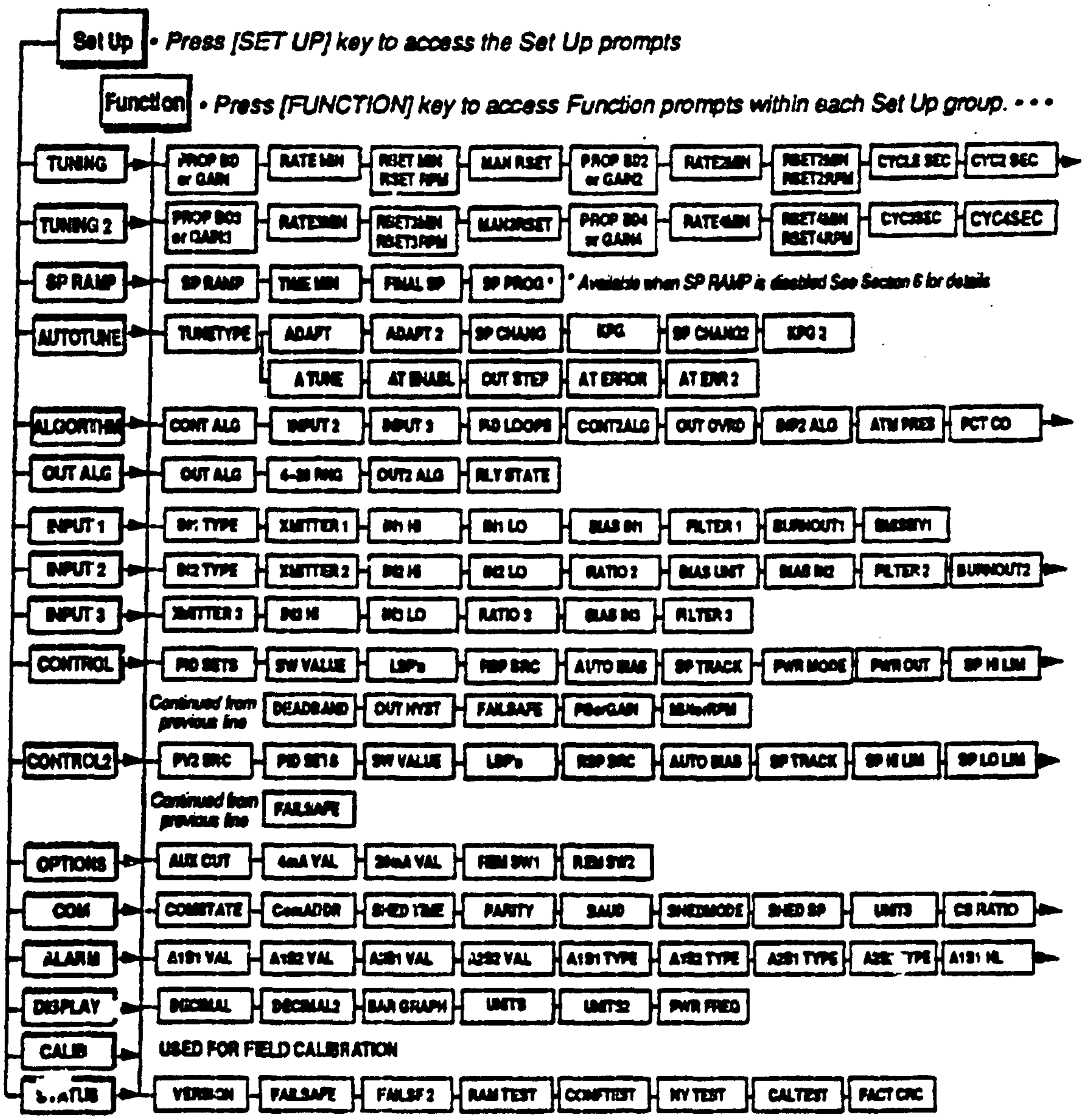
Continued on next page

3.2 Configuration Prompts

Diagram: prompt hierarchy

Figure 3-1 shows an overview of the UDC5000 Set Up prompts and their associated Function prompts. - Read from left to right.

Figure 3-1 Overview of UDC5000 Prompt Hierarchy



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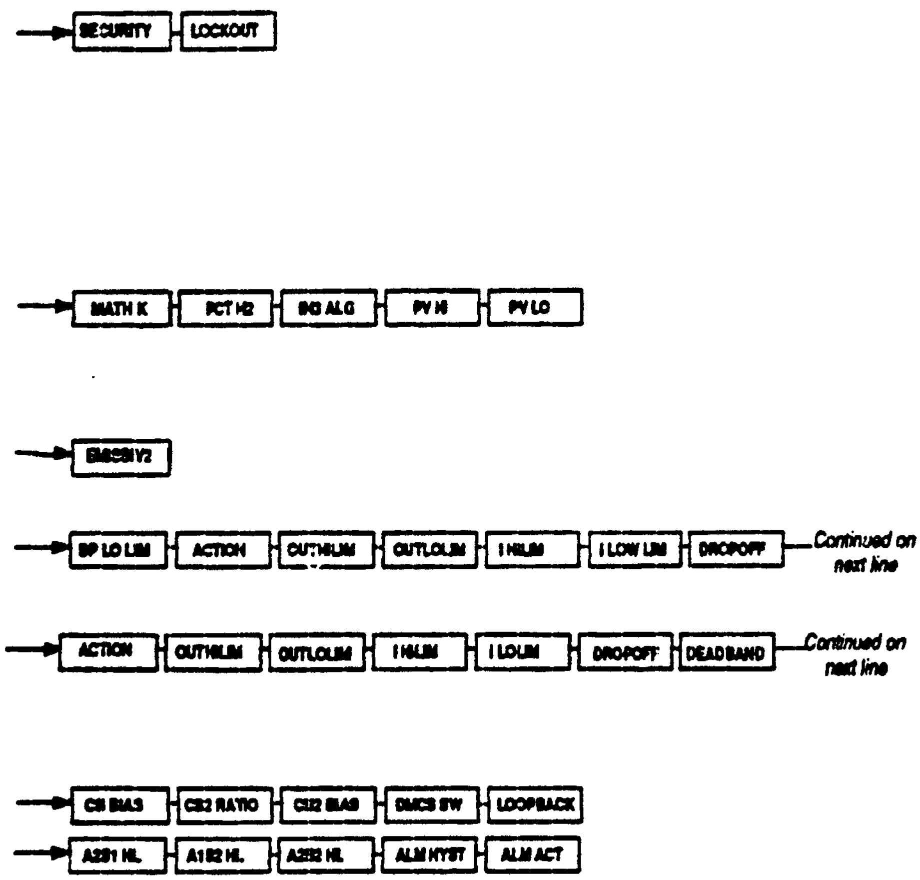
3.2 Configuration Prompts, Continued

• • • Press [▲] or [▼] to change the value or selection of the Function prompt.



3.3 How To Get Started

Read the configuration tips	Read "*Configuration Tips*" shown on the next page. These tips will help you to easily and quickly accomplish the tasks at which you will be working when you configure your controller.
Read configuration procedure	Read "*Configuration Procedure*". This procedure tells you how to access the Set Up groups, and the Function parameters within each of the groups that are shown in the Prompt Hierarchy in Figure 3-1.
Set Up groups	The Set Up groups and Function parameters are listed in the order of their appearance. The list includes the name of the prompt, the range of setting or selections available, and the factory setting.
Parameter explanations or definitions	If you need a detailed explanation of any prompt listed, refer to ***Section 4 – Configuration Parameter Definitions.*** This section lists the Set Up and Function prompts, the selections or range of settings that you can make for each, plus a detailed explanation or definition of each parameter
Configuration record sheet	Located on the last page of this section is a "*Configuration Record Sheet*". When you make your configuration selections, record them on this sheet. Then you will have a record of how the controller was configured.

3.4 Configuration Tips

Introduction

Listed below in Table 3-1 are a few tips that will help you enter the configuration data more quickly.

Table 3-1 Configuration Tips

Function	Tip
Displaying Groups	Use the [SET UP] key to display the Set Up groups. The group titles are listed in this section in the order that they appear in the controller.
Displaying Functions	Use the [FUNC] key to display the individual parameters under each group. The prompts are listed in the order of their appearance in each group.
Scrolling	To get to a Set Up group prompt more quickly, hold the [SET UP] key in. To get to a Function prompt more quickly, hold the [FUNC] key in. The display will scroll through the parameters. [ATTENTION] The prompting scrolls at a rate of 2/3 seconds when the [SET UP] or [FUNC] key is held in. Also, [▲] [▼] keys will move group prompts forward or backward at a rate twice as fast.
Changing values quickly	When Changing the value of a parameter, you can adjust a more significant digit in the upper display by holding in one key [▲] or [▼], and pressing the other [▲] or [▼] at the same time. The adjustment will move one digit to the left. Press the key again and you will move one more digit to the left.
Restoring to the original value	When you change the value or selection of a parameter while in Set Up mode and decide not to enter it, press [RUN/HOLD] key once, the original value or selection will be recalled.
Exiting SET UP mode	To exit Set Up mode, press the [LOWR DISP] key. This returns the display to the same state it was in immediately preceding entry into the Set Up mode.
Timing out from Set Up mode	If you are in Set Up mode and do not press any keys for one minute, the controller will time out and revert to the mode and display that was being used prior to entry into Set Up mode and stores any changes you have made.
Key Error	When a key is pressed and the prompt "KEY ERROR" appears in the lower display, it will be for one of the following reasons: • parameter not available • not in Set Up mode, press [SET UP] key first • key malfunction, do keyboard test (operation) • Individual key locked out

3.5 Configuration Procedure

Introduction

Each of the Set Up groups and their functions are pre-configured at the factory.
The factory settings are shown in the Set Up group tables that follow this procedure.
If you want to change any of these selections or values, follow the procedure in Table 3-2. This procedure tells you the keys to press to get to any Set Up group and any associated Function parameter prompt.
If you need a detailed explanation of any prompt, refer to *Section 4 – Configuration Parameter Definitions*.

Procedure

Follow the procedure listed in Table 3-2 to access the Set Up groups and Function prompts.

ATTENTION The prompting scrolls at a rate of 2/3 seconds when the SET UP or FUNC key is held in. Also, ▲ ▼ keys will move group prompts forward or backward at a rate twice as fast.

Table 3-2 Configuration Procedure

Step	Operation	Press	Result
1	Select Set Up mode	SET UP	Upper Display: SET UP — Lets you know you are in the configuration mode and a Set Up group title is being displayed in the lower display. Lower Display: TUNING — This is the first Set Up group title.
2	Select any Set Up group	SET UP	Successive presses of the SET UP key will sequentially display the other Set Up group titles shown in the prompt hierarchy in figure 3-1. You can also use the ▲ ▼ keys to scan the Set Up groups in both directions. Stop at the Set Up group title which describes the group of parameters you want to configure. Then proceed to the next step.
3	Select a Function Parameter	FUNC	Upper Display: 1.0 — Shows you the current value or selection for the first function prompt of the particular Set Up group that you have selected. Lower Display: GAIN — Shows the first Function prompt within that Set Up group. Example displays show Set Up group "Tuning", Function prompt "Gain" and the valu[illegible]

Table 3-2 continued on next page

Procedure (continued)

Table 3-2 Configuration Procedure, continued

Step	Operation	Press	Result
4	Select other Function Parameters	FUNC	Successive presses of the FUNC Key will sequentially display the other function prompts of the Set Up group you have selected. Stop at the function prompt that you want to change, then proceed to the next step.
5	Change the value or selection	▲ or ▼	These keys will increment or decrement the value or selection that appears for the function prompt you have selected. See "Configuration Tips" for instructions to increase or decrease value quickly. Change the value or selection to meet your needs. If the display flashes, you are trying to make an unacceptable entry.
6	Enter the value or selection	FUNC or SET UP	This key selects another function prompt. This key selects another Set Up group. The value or selection you have made will be entered into memory after another key is pressed.
7	Exit Configuration	LOWR DISP	This exits configuration mode and returns the controller to the same state it was in immediately preceding entry into the Set Up mode. It stores any changes you have made.

3.6 Tuning Parameters Set Up Group

Introduction

The Tuning Set Up group contains the Function parameters that will allow your controller to respond correctly to changes in process variable or setpoint.

You can start with predetermined values but you will have to watch your process to determine how to modify them.

If you have the Autotune/Adaptive Tune option, this will automatically select Gain, Rate, and Reset values.

Set this group last

Because this group contains functions that have to do with Security and Lockout, it is best to configure this group last, after all the other configuration data has been loaded.

Duplex Heat Cool

See Table 4-2 in *Section 4 - Prompt Definitions* for Duplex Heat/Cool designations.

Continued on next page

Function prompts

Table 3-3 lists all the function prompts in the Tuning Set Up group. How the "Algorithm" and "Control" Set Up groups are configured determines which prompts will appear.

Table 3-3 Tuning Group Function Prompts

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
PROP BD or GAIN	Proportional Band, or Gain	0.1 to 9999 (PB) 0.1 to 1000 (Gain)	-- 1.0
RATE MIN	Rate in Minutes	0.08 to 10.00 minutes (0.00=Off)	0.00
RSET MIN	Reset in minutes/repeat	0.02 to 50.00	1.0
RSET RPM	Reset in repeats/minute	0.02 to 50.00	1.0
MAN RSET	Manual Reset	−100 to 100% Output	0
PROP BD2 or GAIN 2	Proportional Band 2, or Gain 2	0.1 to 9999 (PB) 0.1 to 1000 (Gain)	-- 1.0
RATE2MIN	Rate 2 in Minutes	0.08 to 10.00 minutes (0.00=Off)	0.00
RSET2MIN	Reset 2 in minutes/repeat	0.02 to 50.00	1.0
RSET2RPM	Reset 2 in repeats/minute	0.02 to 50.00	--
CYC SEC	Cycle Time (Heat)	1 to 120 seconds	4
CYC2 SEC	Cycle Time 2 (Cool)	1 to 120 seconds	4
SECURITY	Security Code	1 to 4095	0
LOCKOUT	Configuration Lockout	NONE CALIB +CONF +VIEW MAX	CALIB

Continued on next page

3.7 Tuning 2 Parameters Set Up Group (Cascade or 2 Loop)

Function prompts

Table 3-4 lists all the function prompts in the Tuning 2 Set Up group. This group is only displayed if the controller is configured for "Cascade" or "2 Loop" control at prompt "PV2SRC"

Table 3-4 Tuning 2 Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
PROPBD3 or GAIN3	Proportional Band 3, or Gain 3	0.1 to 9999 (PB) 0.1 to 1000 (Gain)	-- 1.0
RATE 3 MIN	Rate 3 in Minutes	0.08 to 10.00 minutes (0.00=Off)	0.00
RSET3MIN RSET3RPM	Reset 3 in minutes/repeat Reset 3 in repeats/minute	0.02 to 50.00 0.02 to 50.00	1.0 --
MAN 3RSET	Manual Reset 3	–100 to 100% Output	50.0
PROPBD4 or GAIN 4	Proportional Band 4, or Gain 4	0.1 to 9999 (PB) 0.1 to 1000 (Gain)	-- 1.0
RATE4MIN	Rate 4 in Minutes	0.08 to 10.00 minutes (0.00=Off)	0.00
RSET4MIN RSET4RPM	Reset 4 in minutes/repeat Reset 4 in repeats/minute	0.02 to 50.00 0.02 to 50.00	1.0 --
CYC 3SEC	Cycle Time 3(Heat)	1 to 120 seconds	4
CYC 4SEC	Cycle Time 4 (Cool)	1 to 120 seconds	4

3.8 SP Ramp/Program Set Up Group

Single Setpoint Ramp

The Setpoint Ramp Set Up group contains the Function parameters that let you to configure a single set point ramp to occur between the current local setpoint and a final setpoint over a time interval (SP RAMP).

Setpoint Program

The Setpoint Ramp Set Up group also contains function parameters that let you configure a specific Ramp/Soak Program. SP RAMP must be disabled to allow SP PROG. *See Section 6 - Setpoint Ramp/Soak Programming for details.*

Function prompts

Table 3-5 lists all the function prompts in the SP RAMP Set Up group.

Table 3-5 SP Ramp Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
SP RAMP	Single Setpoint Ramp Selection	DISABL ENABLE ENABL2 ENABL12	DISABL
TIME MIN	Single Setpoint Ramp Time	0 to 255 minutes	3
FINAL SP	Single Setpoint Final Setpoint	Enter a value within the setpoint limits	1000
SP PROG (See Section 6)	Setpoint Ramp/Soak Program	DISABL ENABLE ENABL2 ENABL12	DISABL

3.9 Autotune/Adaptive Tune Set Up Group

Adaptive Tune

Adaptive Tune continuously adjusts the PID parameters in response to setpoint changes and/or Process Variable disturbances. You can select tuning on minimum setpoint changes of 5% up to 15% span. Perform adaptive tuning after you have configured the controller.
Adaptive Tune does not work with 3 Position Step Control algorithm.

Autotune

Autotune automatically calculates PID tuning cocnstants on demand based on an Output Step introduced onto the process. You can select an Output Step size of from −100 to +100% of output.

Function prompts

Table 3-6 lists all the function prompts in the "AUTOTUNE' Set Up group.

Table 3-6 Autotune Group Function Prompts

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
TUNETYPE	Autotune Type	ADAPT* A TUNE **	A TUNE
ADAPT *	Adaptive Tune - LOOP 1	DISABLE SPoNLY SP + PV	DISABLE
ADAPT2 *	Adaptive Tune - LOOP 2	DISABLE SPoNLY SP + PV	DISABLE
SP CHANG*	Setpoint Change Value	5 to 15% Input Span	10
KPG*	Process Gain Value	0.10 to 50.00	1.0
SP CHANG2*	Setpoint Change Value - Loop 2	5 to 15% Input Span	10
KPG 2*	Process Gain - Loop 2	0.10 to 50.00	1.0
A TUNE**	Autotune	DISABL A STEP M STEP A STEP2 M STEP2	DISABLE
OUT STEP**	Output Step Size	−100 to +100% of Output in 1% increments	--
AT ERROR or AT ERR 2 (depending on Loop)	Autotune Error codes	Read Only NONE +LIM OUT LIM -P-LIM DUPLIM ABORT ALARM 1 INPUT LOW PV RAMP ID FAIL REM SW	--

3.10 Algorithm Data Set Up Group

Introduction

This data deals with various algorithms residing in the controller: Control Algorithms, Input algorithms, Enabling the 2nd or 3rd input, Selecting the Number of PID Loops, Control algorithm for Loop 2, and Output Override.

Function prompts

Table 3-7 lists all the function prompts in the "ALGORITHM" Set Up group.

Table 3-7 Algorithm Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
CONT ALG	Control Algorithm	ON-OFF PID A PID B PD+MR 3PSTEP	PID A
INPUT 2	Input 2 selection	ENABL DISABL	ENABL
INPUT 3	Input 3 selection	ENABL DISABL	ENABL
PID LOOPS	PID Loop Selection	1 LOOP 2 LOOPS CASCAD	1 or 2
CONT2 ALG	Control 2 Algorithm	PID A PID B PD+MR	PID A
OUT OVRD	Output Override Select	DISABLE HI SEL LO SEL	DISABL
IN P2 ALG	Input 2 Algorithm (formulas are located in Section 4)	NONE W AVG REL HUM FFWRD ADDER SUBTRC SUMwRB HI SEL LO SEL HI SEL+ LO SEL+ √MU DIV √MUL T MU DIV MULT FFWRD2 CARB A CARB B CARB C CARB D FCC OXYGEN DEW PT	NONE
ATM PRES	Atmospheric Pressure Compensation	590.0 to 760.0	760.0

Table 3-7 continued on next page

Function prompts (cocntinued)

Table 3-7 Algorithm Group Function Prompts, continued

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
PC CO	Percent Carbon Monoxide	0.02 to 0.350(%CO)	0.2
MATH K	Weighted Average Ratio or K Constant for Math Selections	0.001 to 9.999	1.00
PCT H_2	Hydrogen Content	1 to 99(%H_2)	--
INP3 ALG	Input 3 Algorithm	NONE FFWRD SUMwRB HI SEL+ LO SEL+ FFWRD2	NONE
PV HI	Process Variable High Range for second and third input algorithms	–999 to 9999	1000
PV LO	Process Variable Low Range for second and third input algorithms	–999 to 9999	0

3.11 Output Algorithm Parameters Set Up Group

Introduction

This data deals with various Output algorithms that are available for use in the controller. It also lists the Relay State, and the Current Duplex functionality.

Function prompts

Table 3-8 lists all the function prompts in the "OUT ALG" Set Up group.

Table 3-8 Output Algorithm Group Function Prompts

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
OUT ALG	Loop 1 Output Algorithm	TIME CURRNT POSITN TIME D CUR D CUR TI TI CUR	CURRENT
4–20 RNG	Current Duplex Range	100PCT 50PCT	100PCT
OUT2 ALG	Loop 2 Output Algorithm	NONE TIME CURRNT CUR D CUR TI TI CUR	TIME
RLY STATE	Duplex Relay Status at 0% Output	1OF 2OF 1ON 2OF 1OF 2ON 1ON 2ON	1OF 2ON

3.12 Input 1 Parameters Set Up Group

Introduction

This data deals with various parameters required to configure Input 1; actuation, transmitter characterization, high and low range values in engineering units, bias, filter, and burnout.

Function prompts

Table 3-9 lists all the function prompts in the "INPUT 1" Set Up group.

Table 3-9 Input 1 Set Up Groups Function Prompts

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
INP1 TYP	Input 1 Type	B, EH, EL, JH, JL, KH, KL, NNMH, NNML, NIC, R, S, TH, TL, WH, WL, 100 PT, 100 LO, 100 RH, 200 PT, 500 PT, RADIAM, 4–20MA, 0–10MV, 10–50MV, 1–5V, 0–10V	0–10MV
XMITTER1	Transmitter Characterization	B, EH, EL, JH, JL, KH, KL, NNMH, NNML, NIC, R, S, TH, TL, WH, WL, 100 PT, 100 LO, 100 RH, 200 PT, 500 PT, LINEAR, SQROOT	LINEAR
IN1 HI	Input 1 High Range Value (Linear Inputs only	–999 to 9999 in engineering units	1000
IN1 LO	Input 1 Low Range Value (Linear Inputs only)	–999 to 9999 in engineering units	0
BIAS IN 1	Input 1 Bias Value	–999 to 9999.	0
FILTER 1	Input 1 Filter	0 to 120 seconds	0
BURNOUT 1	Sensor Break Protection	NONE, UP, DOWN	None
EMISSIVITY1	Emissivity	0.10 to 1.00	1.00

3.13 Input 2 Parameters Set Up Group

Introduction

This data deals with various parameters required to configure Input 2; actuation, transmitter characterization, high and low range values in engineering units, ratio, bias, filter, burnout, and emissivity.

Function prompts

Table 3-10 lists all the function prompts in the "INPUT 2" Set Up group.

Table 3-10 Input 2 Set Up Groups Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
INP2 TYP	Input 2 Type	B EH EL JH JL KH KL NNMH NNML NIC R S TH TL WH WL 100 PT 100 LO 100 RH 200 PT 500 PT RADIAM 4–20MA 0–10MV 10–50MV 1–5V 0–10V CARBON OXYGEN	0–10MV
XMITTER2	Transmitter Characterization	B EH EL JH JL KH KL NNMH NNML NIC R S TH TL WH WL 100 PT 100 LO 100 RH 200 PT 500 PT LINEAR SQROOT	LINEAR
IN2 HI	Input 2 High Range Value (Linear Inputs only	–999 to 9999 in engineering units	1000
IN2 LO	Input 2 Low Range Value (Linear Inputs only)	–999 to 9999 in engineering units	0
RATIO 2	Ratio 2	–20.00 to 20.00	1.00
BIASUNIT	Bias Units	ENG PERCNT	ENG
BIAS IN2	Bias Input 2 Value	–999 to 9999 Engr. Units –999 to 2000% of Input Span	0
FILTER 2	Input 2 Filter	0 to 120 seconds	0
BURNOUT 2	Sensor Break Protection	NONE UP DOWN	None
EMISSIVITY2	Emissivity	0.10 to 1.00	1.00

3.14 Input 3 Parameters Set Up Group

Introduction

This data deals with various parameters required to configure Input 3; transmitter characterization, high and low range values in engineering units, ratio, bias, and filter.

Function prompts

Table 3-11 lists all the function prompts in the INPUT 3 Set Up group.

Table 3-11 Input 3 Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
XMITTER3	Transmitter Characterization	B EH EL JH JL KH KL NNMH NNML NIC R S TH TL WH WL 100 PT 100 LO 100 RH 200 PT 500 PT LINEAR SQROOT	LINEAR
IN3 HI	Input 3 High Range Value	−999 to 9999 in engineering units (Adjustable for linear inputs only)	1000
IN3 LO	Input 3 Low Range Value	−999 to 9999 in engineering units (Adjustable for linear inputs only)	0
RATIO 3	Input 3 Ratio Value	−20.00 to 20.00	1.0
BIAS IN3	Input 3 Bias Value	−999 to 9999 in engineering units	0
FILTER 3	Input 3 Filter	0 to 120 seconds 0 = No Filter	0

3.15 Loop 1 Control Parameters Set Up Group

Introduction

The functions listed in this group define how the Single Loop process controller or Loop 1 of a Two Loop process controller will control the process.

Function prompts

Table 3-12 lists all the function prompts in the "CONTRC' Set Up group.

Table 3-12 Control Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
PID SETS	Tuning Parameter Sets	1 ONLY 2KEYBD 2PV SW 2SP SW	1 ONLY
SW VALUE	Automatic Switchover Value	Value in Engineering Units within Input Range	0.00
LSP'S	Local Setpoint Source	1 ONLY TWO THREE	1 ONLY
RSP SRC	Remote Setpoint Source	NONE IN 2 IN 3	NONE
AUTO BIAS	Automatic Bias	ENABLE DISABLE	DISABLE
SP TRACK	Local Setpoint Tracking	NONE PV RSP	NONE
PWR MODE	Power Up Mode Recall	MANUAL A M SP A M LSP	A or M SP
PWR OUT	Power Up Output Select	LAST F'SAFE	F'SAFE
SP HILIM	Setpoint High Limit	0 to 100% of PV in engineering units	1000
SP LOLIM	Setpoint Low Limit	0 to 100% of PV in engineering units	0

Table 3-12 continued on next page

Function prompts, continued Table 3-12 lists all the function prompts in the "CONTROL" Set Up group.

Table 3-12 Control Group Function Prompts, continued

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
ACTION	Control Output Direction	DIRECT REVERSE	REVERSE
OUTHILIM	High Output Limit	–5.0 to 105.0% of output	100.0
OUTLOLIM	Low Output Limit	–5.0 to 105.0% of output	0.0
I HI LIM	High Reset Limit	Within the range of the output limits	100.0
I LO LIM	Low Reset Limit	Within the range of the output limits	0.0
DROPOFF	Controller Dropoff Value	–5.0 to 105.0% of output	0.0
DEADBAND	Output Relay Deadband	*Duplex: only* –5.0 to 25.0% *All others* 0.0 to 25.0%	1.0
OUT HYST	Output Relay Hysteresis	0.0 to 5.0% of PV Span for On/Off control	0.5
FAILSAFE	Failsafe Output Value	Set within the range of the output limits. 0 to 100%	0.0
PBorGAIN	Proportional Band or Gain Units	PB PCT GAIN	GAIN
MINorRPM	Reset Units	RPM MIN	MIN

3.16 Loop 2 Control Parameters Set Up Group

Introduction The functions listed in this group define how Loop 2 of a Two Loop process controller will control the process.

Function prompts Table 3-13 lists all the function prompts in the "CONTROL2" Set Up group.

Table 3-13 Control2 Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
PV 2 SRC	Process Variable Source	IN 1 IN 2 IN 3	INPUT 2
PID SETS	Tuning Parameter Sets	1 ONLY 2KEYBD 2PV SW 2SP SW	1 ONLY
SW VALUE	Automatic Switchover Value	Value in Engineering Units within Input Range	0.00
LSP'S	Local Setpoint Source	1 ONLY TWO THREE	1 ONLY
RSP SRC	Remote Setpoint Source	NONE IN 2 IN 3	NONE
AUTO BIAS	Automatic Bias	ENABLE DISABLE	DISABLE
SP TRACK	Local Setpoint Tracking	NONE PV RSP	NONE
SP HILIM	Setpoint High Limit	0 to 100% of PV in engineering units	100.0
SP LOLIM	Setpoint Low Limit	0 to 100% of PV in engineering units	0.0

Table 3-13 continued on next page

Function prompts, continued

Table 3-13 lists all the function prompts in the "CONTROL2" Set Up group.

Table 3-13 Control2 Group Function Prompts, continued

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
ACTION	Control Output Direction	DIRECT REVERSE	REVERSE
OUTHILIM	High Output Limit	–5.0 to 105.0% of output	100.0
OUTLOLIM	Low Output Limit	–5.0 to 105.0% of output	0
IHILIM	High Reset Limit	Within the range of the output limits	100.0
ILOLIM	Low Reset Limit	Within the range of the output limits	0.0
DROPOFF	Controller Dropoff Value	–5.0 to 105.0% of output	0.0
DEADBAND	Output Relay Deadband	*Duplex: only* –5.0 to 25.0% *All others* 0.0 to 25.0%	1.0
FAILSAFE	Failsafe Output Value	Set within the range of the output limits. 0 to 100%	0.0

3.17 Options Set Up Group

Introduction

This data deals with data that covers the Auxiliary Output and the Two Remote Switch selections. If your controller does not have any of these options, the prompts will not appear.

Function prompts

Table 3-14 lists all the function prompts in the "Options" Set Up group.

Table 3-14 Options Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
AUX OUT	Auxiliary Output Option	DISABL IN 1 IN 2 PV DEV OUTPUT SP IN 3 PV 2 DEV 2 OUT 2 SP 2	DISABL
4mA VAL	Low Scaling Factor	Low scale value to represent 4 mA.	0.0
20mA VAL	High Scaling Factor	High scale value to represent 20 mA.	100.0
REM SW1	Remote Switching 1 selections	NONE To MAN To SP1 To SP2 To DIR To HOLD ToPID2 PV IN2 PV IN3 To RUN To BGN	NONE
REM SW2	Remote Switching 2 selections	Same as "REM SW1"	NONE

3.18 Communications Group

Introduction

This data deals with the Communications option that is available with your controller. This option allows the controller to be connected to a host computer via a RS422/485 or DMCS bus.

If your controller does not have this option, the prompts will not appear.

Function prompts

Table 3-15 lists all the function prompts in the "COM" Set Up group.

Table 3-15 Commun Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
ComSTATE	Communications Option State	DISABL DMCS RS422/485	DISABL
ComADDR	Communications Station Address (Loop 1) RS422 or DMCS	1 to 31 (DMCS) 1 to 99 (RS422)	3
ComADDR2	Communications Station Address (Loop 2) RS422 or DMCS	1 to 31 (DMCS) 1 to 99 (RS422)	0
SHEDTIME	Shed Time	0 to 255 sample periods 0 = No Shed	30
PARITY (RS422/485 Only)	Parity	ODD EVEN	ODD
BAUD (RS422/485Only)	Baud Rate	300 4800 600 9600 1200 19200 2400	19200

Table 3-15 continued on next page

3.18 Communications Group, continued

Function prompts Table 3-15 lists all the function prompts in the "Commun" Set Up group.

Table 3-15 Commun Group Function Prompts, continued

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
SHEDMODE	Shed Controller Mode and Output Level	LAST TO MAN FSAFE TO AUTO	LAST
SHED SP	Shed Setpoint Recall	TO LSP TO CSP	TO LSP
UNITS	Communication Units	PERCNT ENG	PERCNT
CS RATIO	Loop 1 Computer Setpoint Ratio	–20.00 to 20.00	1.00
CS BIAS	Loop 1 Computer Setpoint BIAS	–999.0 to 9999 Engineering Units –999 to 2000% of CSP Span	0.0
CS2 RATIO	Loop 2 Computer Setpoint Ratio	–20.00 to 20.00	1.00
CS2 BIAS	Loop 2 Computer Setpoint BIAS	–999.0 to 9999 Engineering Units –999 to 2000% of CSP Span	0.0
DMCS SW	DMCS Type Selection	ULTRA 5000	5000
LOOPBACK (DMCS Only)	Local Loop Back	DISABL ENABLE	DISABL

3.19 Alarm Parameter Set Up Group

Introduction

This data deals with the Alarms function that is available with your controller.

There are two alarms available. Each alarm has two setpoints.

You can configure each of these two setpoints to alarm on one of several events, and you can configure each setpoint to alarm High or Low.

Function prompts

Table 3-16 lists all the function prompts in the "Alarms" Set Up group.

Table 3-16 Alarms Group Function Prompts

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
A1S1 VAL	Alarm 1, Setpoint 1 Value	Within the range of selected parameter or PV Span for Deviation Alarm	90
A1S2 VAL	Alarm 1, Setpoint 2 Value	Within the range of selected parameter or PV Span for Deviation Alarm	10
A2S1 VAL	Alarm 2, Setpoint 1 Value	Within the range of selected parameter or PV Span for Deviation Alarm	95
A2S2 VAL	Alarm 2, Setpoint 2 Value	Within the range of selected parameter or PV Span for Deviation Alarm	5
A1S1 TYPE	Alarm 1, Setpoint 1 Type	NONE IN 1 IN 2 PV (Process Variable) DEV OUTPUT SHED (Communications) EV ON EV OFF IN 3 PV 2 DEV 2 OUT 2	OUTPUT
A1S2 TYPE	Alarm 1, Setpoint 2 Type	Same as A1S1TYPE	OUTPUT

Table 3-16 continued on next page

3.19 Alarm Parameter Set Up Group, Continued

Function prompts, continued

Table 3-16 lists all the function prompts in the "Alarms" Set Up group.

Table 3-16 Alarms Group Function Prompts, continued

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
A2S1 TYPE	Alarm 2, Setpoint 1 Type	Same as A1S1TYPE	OUTPUT
A2S2 TYPE	Alarm 2, Setpoint 2 Type	Same as A1S1TYPE	OUTPUT
A1S1 H L	Alarm 1, Setpoint 1 State	LOW HIGH	HI
A1S1 E V	Alarm 1, Setpoint 1 Event	BEGIN END	--
A1S2 H L	Alarm 1, Setpoint 2 State	LOW HIGH	LO
A1S2 E V	Alarm 1, Setpoint 2 Event	BEGIN END	--
A2S1 H L	Alarm 2, Setpoint 1 State	LOW HIGH	HI
A2S1 E V	Alarm 2, Setpoint 1 Event	BEGIN END	--
A2S2 H L	Alarm 2, Setpoint 2 State	LOW HIGH	LO
A2S2 E V	Alarm 2, Setpoint 2 Event	BEGIN END	--
AL HYST	Alarm Hysteresis	0.0 to 5.0 % of Output or Span as appropriate	0.1
ALM ACTN	Alarm Relay Coil Action	RLYoN RLYoFF	RLYoN

3.20 Display Parameters Set Up Group

Introduction This data deals with the Decimal Place, Units of Temperature, Power Frequency, and Process ID Tag.

Function prompts Table 3-17 lists all the function prompts in the "DISPLAY" Set Up group.

Table 3-17 Display Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
DECIMAL	Control Loop 1 Decimal Place	XXXX XXX.X XX.XX X.XXX	XXXX
DECIMAL2	Control Loop 2 Decimal Place	XXXX XXX.X XX.XX X.XXX	XXXX
BARGRAPH	Bargraph Representation	DEV OUTPUT DEVOUT	DEV
UNITS	Control Loop 1 Temperature Units	DEG F DEG C NONE	NONE
UNITS 2	Control Loop 2 Temperature Units	DEG F DEG C NONE	NONE
PWR FREQ	Power Frequency	60 Hertz 50 Hertz	60HZ

3.21 Calib Group

Calibration data

The prompts used here are for field calibration purposes.
Refer to *Section 7–Input Calibration* in this manual for complete information and instructions

3.22 Status Group

Status Test Data

The prompts used here are read only.
They are used to determine the reason for a controller failure.
Refer to *Section 9– Troubleshooting* in this manual for complete information.

3.23 Configuration Record Sheet

Keep a record Enter the value or selection for each prompt on this sheet so you will have a record of how your controller was configured.

Group Prompt	Function Prompt	Value or Selection	Factory Setting
TUNING	PROP BD		--
	or		
	GAIN		1.0
	RATE MIN		0
	RSET MIN		1.00
	or		
	RSET RPM		--
	or		
	MAN RSET		0
	PROP BD2		--
	or		
	GAIN 2		1.0
	RATE2MIN		0
	RSET2MIN		1.00
	or		
	RSET2RPM		--
	CYCSEC		4
	CYC2SEC		4
	SECURITY		0
	LOCKOUT		CALIB
TUNING2	PROP BD3		--
	or		
	GAIN3		1.0
	GAIN VALn	Read Only	
	RATE3MIN		0
	RSET3MIN		1.0
	or		
	RSET3RPM		--
	or		
	MAN3RSET		0
	PROP BD4		--
	or		
	GAIN 4		1.0
	RATE4MIN		0
	RSET4MIN		1.0
	or		
	RSET4RPM		--
	CYC3SEC		4
	CYC4SEC		4
SP RAMP	SP RAMP		DISABL
	TIME MIN		3
	FINAL SP		1000
	SP PROG		DISABL
AUTOTUNE	TUNETYPE		A TUNE
	ADAPT		DISABL
	A TUNE		DISABL
	OUT STEP		20
	AT ERROR	Read Only	

Group Prompt	Function Prompt	Value or Selection	Factory Setting
ALGORITHM	CONT ALG		PID A
	INPUT 2		
	INPUT 3		
	PID LOOPS		1 or 2
	CONT2ALG		PID A
	OUT OVRD		DISABLE
	INP2 ALG		NONE
	ATM PRES		760.0
	PC CO		0.2
	MATH K		1.00
	INP3 ALG		NONE
	PV HI		1000
	PV LO		0
OUT ALG	OUT ALG		CURRENT
	4-20 RNG		100 PCT
	OUT ALG2		CURRENT
	RLY STATE		3OFF 4ON
INPUT 1	IN1TYPE		0-10MV
	XMITTER1		LINEAR
	IN1 HI		1000
	IN1 LO		0
	BIAS IN1		0
	FILTER 1		0
	BURNOUT1		NONE
	EMMISSIV1		1.00
INPUT 2	IN2TYPE		0-10MV
	XMITTER2		LINEAR
	IN2 HI		1000
	IN2 LO		0
	RATIO2		1.0
	BIAS UNIT		ENG
	BIAS IN2		0
	FILTER 2		0
	BURNOUT2		NONE
	EMMISSIV2		1.00
INPUT 3	XMITTER3		LINEAR
	IN3 HI		1000
	IN3 LO		0
	RATIO3		1.0
	BIAS IN3		0
	FILTER 3		0

Continued next page

3.23 Configuration Record Sheet, Continued

Group Prompt	Function Prompt	Value or Selection	Factory Setting
CONTROL	PID SETS		1 ONLY
	SW VALUE		0
	LSP's		1 ONLY
	RSPSRC		NONE
	AT BIAS		DISABLE
	SP TRACK		NONE
	PWR MODE		AM SP
	PWR OUT		FSAFE
	SP HI LIM		1000
	SP LO LIM		0
	ACTION		REVERS
	OUTHILIM		100.0
	OUTLOLIM		0.0
	I HILIM		100.0
	I LOLIM		0.0
	DROPOFF		0.0
	DEADBAND		1.0
	OUT HYST		0.5
	FAILSAFE		0.0
	PBorGAIN		GAIN
	MINorRPM		MIN
CONTROL2	PV2 SRC		IN 2
	PID SETS		1 ONLY
	SW VALUE		0
	LSP's		1 ONLY
	RSPSRC		NONE
	AT BIAS		DISABL
	SP TRACK		NONE
	SP HILIM		1000
	SP LOLIM		0
	ACTION		REVERS
	OUTHILIM		100.0
	OUTLOLIM		0.0
	I HILIM		100.0
	I LOLIM		0.0
	DROPOFF		0.0
	DEADBAND		1.0
	FAILSAFE		0 or 50
OPTIONS	AUX OUT		OUTPUT
	4mA VAL		0.0
	20mA VAL		100.0
	REM SW1		NONE
	REM SW2		NONE

Group Prompt	Function Prompt	Value or Selection	Factory Setting
COM	COMSTATE		DMCS
	COM ADDR		3
	SHED TIME		30
	PARITY		ODD
	BAUD		19200
	SHEDMODE		LAST
	SHED SP		TO LSP
	UNITS		PERCNT
	CS RATIO		1.00
	CS BIAS		0.0
	CS2RATIO		1.00
	CS2BIAS		0.0
	DMCS SW		5000
	LOOPBACK		DISABLE
ALARMS	A1S1 VAL		90
	A1S2 VAL		10
	A2S1 VAL		95
	A2S2 VAL		5
	A1S1TYPE		OUTPUT
	A1S2TYPE		OUTPUT
	A2S1TYPE		OUTPUT
	A2S2TYPE		OUTPUT
	A1S1 H LEV		HI
	A1S2 H LEV		LO
	A2S1 H LEV		HI
	A2S2 H LEV		LO
	AL HYST		0.1
	ALM ACT		RLY ON
DISPLAY	DECIMAL		XXXX
	DECIMAL2		XXXX
	BARGRAPH		DEV
	UNITS		DEG F
	UNITS2		DEG F
	PWR FREQ		60HZ

Section 4 – Configuration Prompt Definitions

4.1 Overview

Introduction

This section provides information for all the user configurable parameters listed in the *Section 3 - Configuration*. If you aren't familiar with these parameters, this section gives you the parameter prompt, the selection or range of setting that you can make, and a definition of how each parameter setting affects controller performance. It will also refer you to any other prompts that might be affected by your selection.

What's in this section?

The table below lists the topics that are covered in this section. They are listed in the order of their appearance in the controller.

4.2 Tuning Parameters Set Up Group

Introduction

Tuning consists of establishing the appropriate values for the tuning constants for a single loop controller. These parameters are also for Loop 1 of a 2 Loop or Cascade control configuration.
Adaptive Tune/Autotune feature automatically selects Gain, Rate, and Reset.
This section also contains Keyboard Lockout/Security selections.

Set this group last

Because this group contains functions that have to do with security and lockout, we recommend that you configure this group last, after all the other configuration data has been loaded.

Tuning group prompts

Table 4-1 lists all the function prompts in the Tuning setup group and their definitions.

Table 4-1 Tuning Group Prompt Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PROP BD or GAIN	0.1 to 9999% or 0.1 to 1000	PROPORTIONAL BAND is the percent of the range of the measured variable for which a proportional controller will produce a 100% change in its output. GAIN is the ratio of output change (%) over the measured variable change (%) that caused it. $G = \frac{100\%}{PB\%}$ where PB is the proportional band (in %) If the PB is 20%, then the Gain is 5. And, at those settings, a 3% change in the error signal (SP-PV) will result in a 15% change in the controller's output due to proportional action. If the Gain is 2, then the PB is 50%. Defined as "HEAT" Gain on Duplex models for variations of Heat/Cool applications or 3 Position charge time. The selection of Prop. Band or Gain is made in the "CONTHOL" parameter group under prompt "PBorGAIN."
RATE MIN	0.08 to 10.00 minutes 0.08 or less = OFF	RATE action, in minutes, affects the controller's output whenever the deviation is changing; and affects it more when the deviation is changing faster. Defined as "HEAT" Rate on Duplex models for variations of Heat/Cool applications. Only available with Control Algorithm s: PID-A, PID-B, PD+MR.

Table 4-1 continued on next page

Table 4-1 Tuning Group Prompt Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
RSET MIN or RSET RPM	0.02 to 50.00	RSET MIN = RESET IN MINUTES / REPEAT RSET RPM = RESET IN REPEATS PER MINUTE RESET (Integral Time) adjusts the controller's output in accordance with both the size of the deviation (SP-PV) and the time it lasts. The amount of the corrective action depends on the value of Gain. The Reset adjustment is measured as how many times proportional action is repeated/minute or how many minutes before one repeat of the proportional action occurs. Used with control algorithm PID-A or PID-B. Defined as "HEAT" Reset on Duplex models for variations of Heat/Cool applications. Not available with control algorithm "PD + MR" The selection of minutes per repeat or repeats per minute is made in the "CONTROL" parameters group under prompt "MINorRPM."
MAN RSET	−100 to +100 (in % output)	MANUAL RESET is only applicable if you use control algorithm PD WITH MANUAL RESET. Because a proportional controller will not necessarily line out at setpoint, there will be a deviation (offset) from setpoint. This eliminates the offset and lets the PV line out at setpoint.
PROP BD2 or GAIN 2	0.1 to 999.9% or 0.1 to 1000	PROPORTIONAL BAND 2 or GAIN 2, RATE 2, and RESET 2 parameters are the same as previously described for "Heat" except that they refer to the cool zone tuning constants on duplex models or the second set of PID constants, whichever is pertinent.
RATE2MIN	0.08 to 10.00 minutes 0.08 or less = OFF	
RSET2MIN RSET2RPM	0.02 to 50.00	
CYC SEC	1 to 120 seconds	CYCLE TIME (HEAT) determines the length of one time proportional output relay cycle. Defined as "HEAT" cycle time for Heat/Cool applications.
CYC2 SEC	1 to 120 seconds	CYCLE TIME 2 (COOL) is the same as above except it applies to Duplex models as the cycle time in the "COOL" zone of Heat/Cool applications or for 2nd set of PID constants.

Table 4-1 continued on next page

4.2 Tuning Parameters Set Up Group, Continued

Table 4-1 Tuning Group Prompt Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SECURITY	0001-4095	SECURITY CODE – The level of keyboard lockout may be changed in the set up mode. Knowledge of a security code may be required to change from one level to another. Select this number here, copy it, and keep it in a secure location. Entering "0" disables the security code feature. NOTE: The Security Code is for keyboard entry only and is not available via communications. Can only be changed if "LOCKOUT" selection is "NONE".
LOCKOUT		LOCKOUT applies to one of the functional groups: Configuration, Calibration, Tuning, Adaptive Tune DO NOT CONFIGURE UNTIL ALL CONFIGURATION IS COMPLETE.
	NONE	No Lockout – all groups read/write.
	CALIB	CALIB – All are available for read/write except for the Calibration.
	+CONF	+CONF – Tuning, SP Ramp, and Adaptive Tune groups are read/write. All other groups are read only. Calibration group is not available.
	+VIEW	+VIEW – Tuning and Setpoint Ramp parameters are read/write. No other parameters are viewable.
	MAX	MAX – Tuning and Setpoint Ramp parameters are available for read only. No other parameters are viewable.

4.3 Tuning Loop 2 Parameters Set Up Group

Introduction

Tuning L2 (Loop 2) consists of establishing the appropriate values for the tuning constants for Loop 2 on 2 Loops or Internal Cascade control.

Tuning group prompts

Table 4-2 lists all the function prompts in the Tuning L2 setup group and their definitions.

Table 4-2 Tuning L2 (Loop 2) Group Prompt Definitions

<table>
<tr><th>Lower Display Prompt</th><th>Upper Display
Range of Setting
or Selection</th><th>Parameter
Definition</th></tr>
<tr><td>PROP BAND3
GAIN 3
RATE3MIN
RESET3MIN or
RESET3RPM
MAN3RESET
PROP BAND4
GAIN 4
RATE4MIN
RESET4MIN or
RESET4RPM
CYC3SEC
CYC4SEC</td><td>Same as "TUNING"</td><td>The definitions listed for the parameters at the left are the same as those listed previously for the TUNING parameters Set Up Group except they are for Loop 2.

The table below shows you how to use them for Duplex Heat/Cool applications.

DUPLEX OUTPUT RANGES
0 TO 50%-TUNING SETS 2 AND 4:COOL
50 TO 100%-TUNING SETS 1 AND 3: HEAT
<table>
<tr><th>Duplex Output Range</th><th>Heat or Cool</th><th>Loop 1</th><th>Loop 2</th></tr>
<tr><td>0 to 50%</td><td>Cool</td><td><u>PID SET 2</u>
Gain 2
Rate 2
Reset 2
Cycle 2</td><td><u>PID SET 4</u>
Gain 4
Rate 4
Reset 4
Cycle 4</td></tr>
<tr><td>50 to 100%</td><td>Heat</td><td><u>PID SET 1</u>
Gain
Rate
Reset
Cycle</td><td><u>PID SET 3</u>
Gain 3
Rate 3
Reset 3
Cycle 3</td></tr>
</table></td></tr>
</table>

4.4 Setpoint Ramp/Program Set Up Group

Single Setpoint Ramp

This data deals with enabling Single Setpoint Ramp function on one or both control loops. You can start or stop the ramp by pressing the [RUN/HOLD] key .
A single setpoint ramp can be configured to occur between the current local setpoint and a final local setpoint over a time interval of from 1 to 255 minutes.

Setpoint Program

The Setpoint Ramp/Program Set Up group also contains a function parameters that lets you configure a specific Ramp/Soak Program. SP RAMP must be disabled to allow SP PROG. *See Section 6 - Setpoint Ramp/Soak Programming for details.*

Setpoint Ramp/ Program group prompts

Table 4-3 lists all the function prompts in the Setpoint Ramp/Program setup group and their definitions.

Table 4-3 Setpoint Ramp/Rate Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SP RAMP		SINGLE SETPOINT RAMP — make a selection to enable or disable the setpoint ramp function. Make sure you configure a ramp time and a final setpoint value.
	DISABL	DISABLE SETPOINT RAMP — Disables the setpoint ramp option
	ENABLE	ENABLE SETPOINT RAMP — Allows the single setpoint ramp prompts for Loop 1 to be shown.
	ENABLE 2	ENABLE SETPOINT RAMP — Allows the single setpoint ramp to run on Loop 2.
	ENABLE 12	ENABLE SETPOINT RAMP — Allows the single setpoint ramp to be run on Loop 1 and Loop 2.
TIME MIN	0 to 255 minutes	SETPOINT RAMP TIME — The time it takes to go from start to final setpoint. Enter the number of minutes desired to reach the final setpoint. A ramp time of "0" implies and immediate change of setpoint.

Table 4-3 continued on next page

Setpoint Ramp/ Program group prompts, continued

Table 4-3 Setpoint Ramp/Rate Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
FINAL SP	Within SP limits	**SETPOINT RAMP FINAL SETPOINT** — Enter the value desired for the final setpoint. The controller will operate at the setpoint set here when ramp is ended. ATTENTION If the ramp is on "HOLD", the held setpoint can be changed by the ▲ ▼ keys. However, the ramp time remaining and original ramp rate is not changed. Therefore, when returning to RUN mode, the setpoint will ramp at the same rate as previous to the local setpoint change and will stop if the final setpoint is reached before the time expires. If the time expires before the final setpoint is reached, it will jump to the final setpoint. ATTENTION SP RAMP will cause the SP portion of Adaptive Tune to abort. PV Tune will continue to function normally.
SP PROG (option)		**SETPOINT RAMP/SOAK PROGRAM** Available only with controllers that contain this option. For reasons of convenience, the information for the prompts when SP PROG is enabled are included in *Section 6 — Setpoint Programming Option.* "SP RAMP" must be disabled.
	DISABL	**DISABL** - Must select disable to use the SP Ramp option.
	ENABLE	**ENABLE** - allows the prompts for Setpoint Programming
	ENABLE 2	**ENABLE 2** - allows the Setpoint Program to run on Loop 2
	ENABLE 12	**ENABL 12** - allows the Setpoint Program to be run on Loop and Loop 2

4.5 Adaptive Tune/ Autotune Set Up Group

Adaptive Tune

Adaptive Tune continuously adjusts the PID parameters in response to process variable disturbances and/or setpoint changes. Also, it can be used during start-up without prior initialization or process knowledge.

Autotune

Autotune automatically calculates Gain, Rate, and Reset time (PID) tuning constants for one or both control loops. When initiated on demand, the Autotune algorithm measures a process step and automatically generates the PID tuning constants needed for no overshoot on your process.

Adaptive Tune /Autotune group prompts

Table 4-4 lists all the function prompts in the "AUTOTUNE" setup group and their definitions.

Table 4-4 Autotune Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
TUNE TYPE (Option)		**TUNING TYPE SELECTION**
	ADAPT	**ADAPTIVE TUNING - See ADAPT**
	A TUNE	**AUTOTUNE - See A TUNE**
ADAPT		**ADAPTIVE TUNE**
	DISABL	**DISABLE ADAPTIVE TUNE** – Disables the Adaptive Tune function.
	SPoNLY	**SETPOINT ONLY** – This selection tunes on setpoint changes only. It employs time domain analysis to accelerate line out at any desired setpoint without prior initialization or process knowledge. SP Only is the recommended start-up mode - to be used when no knowledge of the process tuning values is available. In the Start-up mode, and after enabling ADAPTIVE, the operator simply lines out the process variable in manual mode, selects the desired SP value and switches to automatic mode.
	SP + PV	**SETPOINT PLUS PROCESS VARIABLE** - This selection tunes on setpoint changes but also whenever a PV disturbance of 0.3% span or larger occurs on Loop 1. It will take 1 and 1/2 process cycles around setpoint before any process recognition and re-tuning can occur due to PV disturbances.

Table 4-4 continued on next page

Table 4-4 Autotune Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SP CHANG	5 to 15%	**SETPOINT CHANGE** - The minimum setpoint change that will result in re-tuning must be configured between 5% and 15%: i.e. If the range is 0 to 2400 and 5% is configured, re-tuning will occur if the setpoint change is 120 or larger. If the setpoint change is less than 5 or greater than 15, a "T" will still appear and a change in Gain may be necessary.
KPG	0.10 to 50.00	**PROCESS GAIN** – This is the Gain of the process being tuned on Loop 1. It is automatically calculated during tuning process. This is normally a READ only value. It should only need to be changed if the controller fails to identify the process. In this case, set the value to the algebraic value of PV in percent, divided by output in percent while in the manual mode. ATTENTION Note you must disable Adaptive tune to change tuning constant values from the keyboard.
ADAPTIVE 2		**ADAPTIVE TUNE - Loop 2**
	DISABL	**DISABLE ADAPTIVE TUNE** – Disables the Adaptive Tune function for Loop 2.
	SPoNLY	**SETPOINT ONLY** – This selection tunes on setpoint changes only on Loop 2. It employs time domain analysis to accelerate line out at any desired setpoint without prior initialization or process knowledge. SP Only is the recommended start-up mode - to be used when no knowledge of the process tuning values is available. In the Start-up mode, and after enabling ADAPTIVE, the operator simply lines out the process variable in manual mode, selects the desired SP value and switches to automatic mode.
	SP + PV	**SETPOINT PLUS PROCESS VARIABLE** - This selection tunes on setpoint changes but also whenever a PV disturbance of 0.3% span or larger occurs on Loop 2. It will take 1 and 1/2 process cycles around setpoint before any process recognition and re-tuning can occur due to PV disturbances.
SP CHANG2	5 to 15%	**SETPOINT CHANGE LOOP 2**- The minimum setpoint change on Loop 2 that will result in re-tuning must be configured between 5% and 15%:

Continued on next page

4.5 Adaptive Tune/ Autotune Set Up Group, Continued

Table 4-4 Autotune Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
KPG2	0.10 to 50.00	PROCESS GAIN LOOP 2 – This is the Gain of the process being tuned on Loop 2. It is automatically calculated during tuning process. This is normally a READ only value. It should only need to be changed if the controller fails to identify the process. In this case, set the value to the algebraic value of PV in percent, divided by output in percent while in the manual mode. ATTENTION Note you must disable Adaptive tune to change tuning constant values from the keyboard.
A TUNE		AUTOTUNE FUNCTION
	DISABL	DISABL - Disables Autotune Function
	A STEP	A STEP(Loop 1) - Automatic steps let you perform an Autotune with a step size automatically generated. The controller can be previously operating in automatic mode.
	M STEP	M STEP(Loop 1) - Manual step lets you choose an output step size, in percent, that will be large enough to result in a PV change. The value of the output step size is selected under function prompt "OUT STEP". The controller must be in Manual Mode to initiate Autotune (M Step).
	A STEP2	A STEP(Loop 2) - Automatic steps let you perform an Autotune on Loop 2 with a step size automatically generated. The controller can be previously operating in automatic mode.
	M STEP2	M STEP(Loop 2) - Manual step lets you choose an output step size, in percent, that will be large enough to result in a PV change on Loop 2. The value of the output step size is selected under function prompt "OUT STEP". The controller must be in Manual Mode to initiate Autotune (M Step).
OUT STEP	–100 to +100% of output in 1% increments	OUTPUT STEP SIZE - Choose an output step size, in percent, that will be applied to the output of the controller when Autotune is initiated. This step must be large enough to result in a process variable (PV) change of at least 2.5% of span. This step can be predetermined by stroking the process in manual mode.
AT ERROR		ADAPTIVE TUNE ERROR STATUS – When an error is detected in the Adaptive Tune process, an error prompt will appear. See *Section 5 -Operation* for a list of error prompts.

4.6 Algorithm Data Set Up Group

Introduction

This data deals with various algorithms in the controller:

- Control algorithm,
- Input algorithm,
- Enable the second or third input
- Selecting the Number of PID Loops, and
- Control Algorithm for loop 2
- Output Override.

Algorithm group prompts

Table 4-5 lists all the function prompts in the Algorithm setup group and their definitions.

Table 4-5 Algorithm Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
CONT ALG		The CONTROL ALGORITHM lets you select the type of control that is best for your process.
	ON-OFF	ON/OFF is the simplest control type. The output can be either ON (100%) or OFF (0%). The Process Variable (PV) is compared with the setpoint (SP) to determine the sign of the error (ERROR = PV-SP). The ON/OFF algorithm operates on the sign of the error signal. In Direct Acting Control, when the error signal is positive, the output is 100%; and when the error signal is negative, the output is 0%. If the control action is reverse, the opposite is true. An adjustable overlap (Hysteresis Band) is provided between the on and off states. Other prompts affected: "OUT HYST" DUPLEX ON/OFF is an extension of this algorithm when the output is configured for Duplex. It allows the operation of a second ON/OFF output. There is a deadband between the operating ranges of the two inputs and an adjustable overlap (hysteresis) of the on and off states of each output. Both Deadband and Hysteresis are separately adjustable With no relay action the controller will read 50%. Other prompts affected: "OUT HYST" and "DEADBAND"

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
CONT ALG continued	PID A NOTE: PID A should not be used for Proportional only action, i.e. no integral (reset) action. Instead, use PD+MR with rate set to 0.	**PID A** is normally used for three-mode control. This means that the output can be adjusted somewhere between 100% and 0%. It applies to all three control actions — Proportional (P), Integral (I), and Derivative (D) — to the error signal. Proportional (Gain) — regulates the controller's output in proportion to the error signal (the difference between Process Variable and Setpoint). Integral (Reset) – regulates the controller's output to the size of the error and the time the error has existed. (The amount of corrective action depends on the value of proportional Gain.) Derivative (Rate) – regulates the controller's output in proportion to the rate of change of the error. (The amount of corrective action depends on the value of proportional Gain.)
	PID B	**PID B** Unlike the PID-A equation, the controller gives only an integral response to a setpoint change, with no effect on the output due to the gain or rate action, and it gives full response to PV changes. Otherwise controller action is as described for the PID-A equation. See note on PID-A.
	PD+MR	**PD WITH MANUAL RESET** is used whenever integral action is not wanted for automatic control. The equation is computed with no integral contribution. The MANUAL RESET, which is operator adjustable, is then added to the present output to form the controller output. Switching between manual and automatic mode will not be bumpless. If you select PD with Manual Reset you can also configure the following variations • PD (Two Mode) control, • P (Single Mode) control. Set Rate(D) and/or Reset Time(I) to 0. Other prompts affected: "MAN RSET"
	3PSTEP	**THREE POSITION STEP** - algorithm is an extension of the ON/OFF Duplex control and includes internal feedback of the state of the relays. The effect of this control action is that the ON and OFF time of the output relay change in proportion to the error signal and the Gain and reset time settings.

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INPUT 2	ENABLE DISABLE	**INPUT 2** algorithm allows you to enable or disable the second input. Appears only when input 2 is ordered.
INPUT 3	ENABLE DISABLE	**INPUT 3** algorithm allows you to enable or disable the second input. Appears only when input 3 is ordered.
PID LOOPS		**PID LOOPS** - This is the PID loop selection.
	1 LOOP	**1 LOOP** - select to use one loop of control.
	2LOOPS	**2LOOPS** - Select to use two PID loops of control, each with two sets of tuning parameters and a set of control parameters.
	CASCADE	**CASCADE** - Select for Cascade Control. Cascade control is a control system where the output of one PID loop is used to adjust the setpoint of the second control loop and the second loop's output actually adjusts the final control element.
CONT2 ALG		The **CONTROL 2 ALGORITHM** lets you select the type of control for Loop 2 that is best for your process.
	PID A NOTE: PID A should not be used for Proportional only action. i.e. no integral (reset) action. Instead, use PD+MR with rate set to 0.	**PID A** is normally used for three-mode control. This means that the output can be adjusted somewhere between 100% and 0%. It applies to all three control actions — Proportional (P), Integral (I), and Derivative (D) — to the error signal. Proportional (Gain) — regulates the controller's output in proportion to the error signal (the difference between Process Variable and Setpoint). Integral (Reset) – regulates the controller's output to the size of the error and the time the error has existed. (The amount of corrective action depends on the value of proportional Gain.) Derivative (Rate) – regulates the controller's output in proportion to the rate of change of the error. (The amount of corrective action depends on the value of proportional Gain.)
	PID B	**PID B** Unlike the PID-A equation, the controller gives only an integral response to a setpoint change, with no effect on the output due to the gain or rate action, and it gives full response to PV changes. Otherwise controller action is as described for the PID-A equation. See note on PID-A.

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
CONT2 ALG, continued	PD+MR	PD WITH MANUAL RESET is used whenever integral action is not wanted for automatic control. The equation is computed with no integral contribution. The MANUAL RESET, which is operator adjustable, is then added to the present output to form the controller output. Switching between manual and automatic mode will not be bumpless. If you select PD with Manual Reset you can also configure the following variations • PD (Two Mode) control, • P (Single Mode) control. Set Rate(D) and/or Reset Time(I) to 0. Other prompts affected: "MAN 3RSET"
OUTOVRD		OUTPUT OVERRIDE SELECT - This selection lets you select high or low output override.
	DISABL	DISABLEs Output Override
	HI SEL	HIGH SELECT - The controller will select the higher of output 1 or output 2 and direct it to output 1 rear terminals.
	LO SEL	LOW SELECT - The controller will select the lower of output 1 or output 2 and direct it to output 1 rear terminals. ATTENTION The unselected output will track the selected output within 5% to eliminate windup in the unselected direction.
INP2 ALG (notdisplayed when linput 2 is disabled)		INPUT 2 ALGORITHM lets you select the algorithm to be applied to input 2. NOTE: All input 2 algorithms operate in engineering Units except for feed forward and general math functions which operate in percent of range units.
	NONE	NONE - No Input 2 algorithm configured
	W AVG	WEIGHTED AVERAGE - When you configure for Weighted Average, the controller will combine the two inputs and compute a PV for the control algorithm from the following equation: $PV = \frac{\text{Input 1} + (K \times \text{Input 2})}{(1 + K)}$ Both Inputs must have the same range in engineering units.

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INP2ALG continued	REL HUM	**RELATIVE HUMIDITY** - Input 1 reads the wet bulb temperature Input 2 reads the dry bulb temperature. Both inputs must be 100 ohm RTD inputs. The controller will indicate measured Relative Humidity as a Process Variable PV) with a setpoint range of 0 to 100% RH.
		INPUT 2 ALGORITHM lets you select the algorithm to be applied to Input 2:
	FFWRD	**FEEDFORWARD** - Feedforward uses Input 2, following a Ratio and Bias calculation as a value summed directly with the PID computed output value and sent, as an output value, to the final control element. Applies to Loop 1 only. This algorithm will only function in automatic mode. The following formula applies: Controller Output= PID Output + (Input2 x Ratio + Bias)
	ADDER	**ADDER WITHOUT RATIO AND BIAS** - The following formula applies: PV = (Input 1 + Bias) + Input 2
	SUBTRC	**SUBTRACTOR WITHOUT RATIO AND BIAS** - The following formula applies: PV = (Input 1 + Bias) – Input 2
	SUMW RB	**SUMMER WITH RATIO AND BIAS**- The following formula applies: In1(EU) + [In2(EU) times R plus Bias] PV = (Input 1 + Bias) + (Input 2 x Ratio + Bias)
	HI SEL	**INPUT HIGH SELECT WITHOUT RATIO AND BIAS** - This selection specifies the PV as the higher of Input 1 or Input 2. The following formula applies: PV = Higher of (Input 1 + Bias) or Input 2
	LO SEL	**INPUT LOW SELECT WITHOUT RATIO AND BIAS** - This selection specifies the PV as the lower of Input 1 or Input 2. The following formula applies: PV = Lower of (Input 1 + Bias) or Input 2
	HI SEL +	**INPUT HIGH SELECT PLUS RATIO AND BIAS** - This selection specifies the PV as the higher of Input 1 or Input 2. The following formula applies: PV = Higher of (Input 1 + Bias) or (Input 2 x Ratio + Bias)
	LO SEL +	**INPUT LOW SELECT PLUS RATIO AND BIAS** - This selection specifies the PV as the lower of Input 1 or Input 2. The following formula applies: PV = Lower of (Input 1 + Bias) or (Input 2 x Ratio + Bias)

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INP2ALG continued	√MUL DIV (note 1)	**MULTIPLIER DIVIDER WITH SQUARE ROOT** - The following formula applies: $$PV = K \times \sqrt{\frac{(\text{Input 1} + \text{Bias}) \times (\text{Input 3} \times \text{Ratio} + \text{Bias})}{(\text{Input 2} \times \text{Ratio} + \text{Bias})}} \; X(PV_{HI} - PV_{LO})$$
		INPUT 2 ALGORITHM lets you select the algorithm to be applied to input 2:
	√MULTIPLY	**MULTIPLIER WITH SQUARE ROOT** - The following formula applies: $$PV = K \times \sqrt{(\text{Input 1} + \text{Bias}) \times (\text{Input 2} \times \text{Ratio} + \text{Bias}) \times (\text{Input 3} \times \text{Ratio} + \text{Bias})} \; X(PV_{HI} - PV_{LO})$$
	MULT DIV	**MULTIPLIER DIVIDER** - The following formula applies: $$PV = K \times \frac{(\text{Input 1} + \text{Bias}) \times (\text{Input 3} \times \text{Ratio} + \text{Bias})}{(\text{Input 2} \times \text{Ratio} + \text{Bias})} \; X(PV_{HI} - PV_{LO})$$
	MULTIPLY	**MULTIPLIER** - The following formula applies: $$PV = K \times (\text{Input 1} + \text{Bias}) \times (\text{Input 2} \times \text{Ratio} + \text{Bias}) \times (\text{Input 3} \times \text{Ratio} + \text{Bias}) \; X(PV_{HI} - PV_{LO})$$
	Where: K = 0.001 to 9.999 (configurable) PV Hi and PV Lo are configurable over a range of –999 to 9999	
	FFWRD 2	**FEEDFORWARD FOR LOOP 2** - This algorithm uses input 2, following a Ratio and Bias calculation as a value summed directly with the PID computer value and sent, as an output value, to the final control element. This algorithm can only be used in automatic mode.
	CARB A	**CARBON POTENTIAL A** - Make this selection if you have a Cambridge or Marathon monitor type Zirconium Oxide sensor as a second input.
	CARB B	**CARBON POTENTIAL B** - Make this selection if you have a Corning type Zirconium Oxide sensor as input 2. This algorithm requires a temperature range for input 1 within the region of 1400 to 2000°F.
	CARB C	**CARBON POTENTIAL C** - Make this selection if you have an A.A.C.C. type Zirconium Oxide sensor as input 2. This algorithm requires a temperature range for input 1 within the region of 1400 to 2000°F.
	CARB D	**CARBON POTENTIAL D**- Make this selection if you have a Barber Coleman, MacDhui, or Bricesco type Zirconium Oxide sensor as input 2. This algorithm requires a temperature range for input 1 within the region of 1400 to 2000°F.

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INP2ALG continued	FCC	**CARBON POTENTIAL FCC** - Make this selection if you have a Furnace Controls Corp Accucarb type Zirconium Oxide sensor as Input 2. This algorithm requires a temperature range for Input 1 within the region of 1400 to 2000°F.
	OXYGEN	**INPUT 2 ALGORITHM** lets you select the algorithm to be applied to input 2.: **PERCENT OXYGEN RANGE** - Make this selection if you are using a Zirconium Oxide Oxygen Probe as a second input to measure Percent of Oxygen in a range of 0 to 40 % O_2. This algorithm requires a temperature range for Input 1 within the region of 800 to 3000°F.
	DEWPOINT	**DEWPOINT OF CARBONIZING ATMOSPHERE** - Use this selection if you are using any Zirconium Oxide Carbon Probe as a second input and you want to measure the atmosphere in terms of Dewpoint. The range is –50 to 100°F or –48 to 38°C. This algorithm requires a temperature range for Input 1 within the region of 1000 to 2200°F.
	ATM PRESS	**ATMOSPHERIC PRESSURE COMPENSATION** - is only applicable for Input 2 algorithm "REL HUM" (Relative Humidity). Enter the value of the atmospheric pressure of the process.
	PCT CO	**PERCENT CARBON** - Only applicable for Input 2 Carbon Potential algorithms. Enter the value in percent carbon monoxide that is applicable for the enriching gas used in fractional form. For example: Natural Gas = 20.0% CO, then make the setting 0.200 Propane Gas = 23.0% CO, then make the setting 0.230

Table 4-5 continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INP2ALG continued		**INPUT 2 ALGORITHM** lets you select the algorithm to be applied to input 2.:
	MATH K	**K CONSTANT FOR WEIGHTED AVERAGE OR MATH SELECTIONS** - Only applicable for Input 2 algorithms "W AVG", or Math selections "√ MULT", √ MULT DIV, "MU DIV", or MULT. When **weighted average** input is configured, the controller will combine the two inputs and compute a PV for the control algorithm from the following equation: $PV = \frac{\text{Input 1} + (K \times \text{Input 2})}{(1 + K)}$ K Range = 0.001 to 9.999 When a **math selection** is configured, the controller will make a calculation resulting in a derived PV. See previous pages for formulas. √ MU DIV √ MULT MU DIV MULT The K value is a configurable constant which is used (along with configurable PV_{HI} and PV_{LO} values) to enable the Math Equation to calculate the proper numerical value in engineering units. Its value is configurable from 0.001 to 9.999 Input 3 applies when enabled and not configured for Feedforward or Remote Setpoint, otherwise the value is entered at 1.0 and does not influence the calculation.
	PCT H_2	**PERCENT HYDROGEN** - Only applicable for input 2 algorithm. Enter the value of percent Hydrogen that is applicable. Range = 1 to 99 (%H_2)

Continued on next page

Table 4-5 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INP3 ALG		**INPUT 3 ALGORITHM** lets you select the algorithm to be applied to Input 3. All third input algorithms operate in Engineering units except Feedforward which operates in percent of range.
	FFWRD	**FEEDFORWARD** - Feedforward uses Input 3, following a Ratio and Bias calculation as a value summed directly with the PID computed output value and sent, as an output value, to the final control element. Applies to Loop 1 only. This algorithm will only function in automatic mode. The following formula applies: Controller Output= PID Output + (Input3 x Ratio + Bias)
	SUMW RB	**SUMMER WITH RATIO AND BIAS**- The following formula applies: PV = (Input 1 + IN1Bias) + (Input 3 x IN3Ratio + IN3Bias)
	HI SEL +	**INPUT HIGH SELECT PLUS RATIO AND BIAS** - This selection specifies the PV as the higher of Input 1 or Input 3. The following formula applies: PV = Higher of (Input 1 + Bias) or (Input 3 x Ratio + Bias)
	LO SEL +	**INPUT LOW SELECT PLUS RATIO AND BIAS** - This selection specifies the PV as the lower of Input 1 or Input 3. The following formula applies: PV = Lower of (Input 1 + Bias) or (Input 3 x Ratio + Bias)
	FFWRD 2	**FEEDFORWARD FOR LOOP 2** - This algorithm uses Input 3, following a Ratio and Bias calculation as a value summed directly with the PID computer value and sent, as an output value, to the final control element. This algorithm can only be used in automatic mode.
PV HI	–999 to 9999	**PROCESS VARIABLE HIGH RANGE FOR SECOND OR THIRD INPUT ALGORITHM** - Only applicable for Input 2 and 3 algorithms "SUMMER", "SUBTRACTOR", "INPUT HI/LO" or one of the general math functions.
PV LO	–999 to 9999	**PROCESS VARIABLE LOW RANGE FOR SECOND OR THIRD INPUT ALGORITHM** - Only applicable for Input 2 and 3 algorithms "SUMMER", "SUBTRACTOR", "INPUT HI/LO" or one of the general math functions.

4.7 Output Algorithm Parameters Set Up Group

Introduction

This data deals with various output types in the controller, the Relay State, and the Current Duplex functionality.

Algorithm group prompts

Table 4-6 lists all the function prompts in the "Output Algorithm" setup group and their definitions.

Table 4-6 Output Algorithm Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
OUT ALG		The OUTPUT ALGORITHM lets you select the type of output you want.
	TIME	RELAY SIMPLEX — This Output algorithm uses one SPDT relay for Time Proportional Control. Its normally open (NO) or normally closed (NC) contacts are selected by positioning an internal jumper. See Section 2 - Installation. Other prompts affected: "OUT HYST".
	CURRNT	CURRENT SIMPLEX — Type of output using one 4 to 20 mA signal that can be fed into a positive or negative grounded load of 0 to 1000 ohms. The signal can be re-calibrated for any desired range from 4 to 20 mA for 0 to 100% output.
	POSITN	POSITION PROPORTIONAL SIMPLEX - This type of output uses two SPDT relays and a motor which has a 100 to 1000 ohm feedback slidewire. Other prompts affected: "DEADBAND"
	TIME D	TIME DUPLEX — This Output algorithm uses two SPDT relays for Time Duplex Proportional Control. Its normally open (NO) or normally closed (NC) contacts are selected by positioning an internal jumper. See Section 2 - Installation. Other prompts affected: "OUT HYST" & "DEADBAND".
	CUR D	CURRENT DUPLEX is similar to current simplex but uses a second current output. The second output is usually scaled so that zero and span correspond with 0% and 50% output (cool zone). When the output is 0 to 50%, the controller uses tuning parameter set #2, when the output is 50 to 100% it uses set #1. Other prompts affected: "4-20 RNG" Auxiliary Output must be configured for "OUTPUT".
	CUR TI	CURRENT/TIME DUPLEX (RELAY = HEAT) is a variation of duplex with current active for 0 to 50% output (tuning set 2) and Time is active 50 to 100% output (tuning set 1). Other prompts affected: "4-20 RNG", "OUT HYST", and "DEADBAND"
	TI CUR	TIME CURRENT DUPLEX (RELAY3= COOL) is similar to "CUR-TI" except that current is active for 50 to 100% and Time is active for 0 to 50%. Other prompts: "4-20 RNG", "OUT HYST", and "DEADBAND"

Table 4-6 continued on next page

Table 4-6 Output Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
4-20 RNG		**CURRENT DUPLEX RANGE ALGORITHM** — Used with Output Algorithm selections "CUR-D," "CUR-TI", or "TI-CUR."
	50 PCT	**CURRENT DUPLEX RANGE (SPLIT)** For "CUR D" this enables the normal control current output to provide its full 4–20mA range for 50% to 100% Output change. This current duplex requires that the Auxiliary output provides cool control which is normally configured to provide 4–20mA over 0–50% of output. To enable this, "OUTPUT" must be selected for Auxiliary Output.
	100PCT	**CURRENT DUPLEX RANGE (FULL)** enables the normal control current output to provide duplex control over 0 - 100% of the controller output by providing cool control over 4–12 mA and Heat control over 12–20 mA. Auxiliary output is not required for this type of duplex operation.
OUTALG 2		The **OUTPUT ALGORITHM** lets you select the type of output you want for the **second** control loop See "OUTALG" for definitions.
	NONE TIME CURRNT CUR TI TIME CUR CUR D	NONE - No selection **See OUT ALG for definitions** ATTENTION Relay Duplex, Position Proportional, and Current/Aux duplex are not allowed on the second control loop.
RLY STATE		**DIGITAL OUTPUT STATUS AT 0% OUTPUT** - allows the following selections:
	1OF 2OF	1OF 2OF Relay 1 de-energized Relay 2 de-energized
	1ON 2ON	1ON 2OF Relay 1 energized Relay 2 de-energized
	1OF 2ON	1OF 2ON Relay 1 de-energized Relay 2 energized
	1ON 2OF	1ON 2ON Relay 1 energized Relay 2 energized ATTENTION For units not configured for Time Duplex or Position Proportional, Relay 2 is always de-energized.

4.8 Input 1 Parameters Set Up Group

Introduction

These are the parameters required for Inputs 1: actuation, transmitter characterization, high and low range values in engineering units, Bias, Filter, and Burnout.

Input 1 group prompts

Table 4-7 lists all the function prompts in the Input 1 setup group and their definitions.

Table 4-7 Input 1 Group definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
IN1 TYPE		**INPUT 1 ACTUATION TYPE** -- This selection determines what actuation you are going to use for input one.
	B TC	B thermocouple 105 to 3300°F 41 to 1816°C
	E TC H	E thermocouple high -454 to 1832°F -270 to 1000°C
	E TC L	E thermocouple low -200 to 1100°F -129 to 593°C
	J TC H	J thermocouple high 0 to 1600°F -18 to 871°C
	J TC L	J thermocouple low 20 to 770°F -7 to 410°C
	K TC H	K thermocouple high 0 to 2400°F -18 to 1316°C
	K TC L	K thermocouple low -20 to 1000°F -29 to 538°C
	NNM H	NiNiMo thermocouple high 32 to 2500°F 0 to 1371°C
	NNM L	NiNiMo thermocouple low 32 to 1260°F 0 to 682°C
	NIC TC	Nicrosil-Nisil thermocouple 0 to 2372°F -17.8 to 1300°C
	R TC	R thermocouple 0 to 3100°F -18 to 1704°C
	S TC	S thermocouple 0 to 3100°F -18 to 1704°C
	T TC H	T thermocouple high -300 to 700°F -184 to 371°C
	T TC L	T thermocouple low -200 to 600°F -129 to 316°C
	W TC H	W5W26 thermocouple high 0 to 4200°F -18 to 2316°C
	W TC L	W5W26 thermocouple low 0 to 2240°F -18 to 1227°C
	100 PT	100 Ohm–RTD -300 to 900°F -184 to 482°C
	100 LO	100 Ohm - RTD 0 to 300°F -18 to 149°C
	200PT	200 Ohm - RTD -300 to 900° F -184 to 482°C
	500 PT	500 Ohm–RTD -300 to 900°F -184 to 482C
	RADIAM	Radiamatic (RH) 1400 to 3400°F 760 to 1871°C
	4-20mA	4 to 20 Milliamps
	10M	0 to 10 Millivolts
	10-50M	10 to 50 Millivolts
	0-5	0 to 5 Volts
	1-5 V	1 to 5 Volts
	0-10 V	0 to 10 Volts

Table 4-7 continued on next page

Table 4-7 Input 1Group definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
XMITTER1	B TC, E TC H, E TC L, J TC H, J TC L, K TC H, K TC L, NNM H, NNM L, NIC TC, R TC, S TC, T TC H, T TC L, W TC H, W TC L, 100 PT, 500 PT, 100 LO, 200PT, LINEAR, SQROOT	**TRANSMITTER CHARACTERIZATION** — This selection lets you instruct the controller to characterize a linear input to represent a non-linear one. NOTE: Prompt only appears when a linear actuation is selected at prompt 'IN1 TYPE". FOR EXAMPLE: If input 1 is a 4 to 20 mA signal, but the signal represents a type "K" thermocouple; select "K TC H" and the controller will characterize the 4 to 20 mA signal so that it is treated as a type "K" thermocouple input (high range). Parameter definitions are the same as shown in Lower Display Prompt "IN1 TYPE"
IN1 HI	–999 to 9999 in Engineering units	**INPUT 1 HIGH RANGE VALUE** in engineering units. Available only if Linear or Square Root transmitter characterization is selected. Scale the #1 input signal to the display value you want for 100%. EXAMPLE: Actuation (Input) = 4 to 20 mA Process Variable = Flow Range of Flow = 0 to 250 Gal/Min High Range display value = 250 Low Range display value = 0 Then 20 mA = 250 Gal/Min The control setpoint will be limited by the range of units selected here.
IN1 LO	–999 to 9999 in Engineering units	**INPUT 1 LOW RANGE VALUE** in engineering units. Available only if Linear or Square Root transmitter characterization is selected. Scale the #1 input signal to the display value you want for 0%. See example on previous page. The control setpoint for Input 1 will be limited by the range of units selected here.
BIAS IN1	–999 to 9999	**BIAS ON INPUT 1** - Bias is used to compensate the input for drift of an input value due to deterioration of a sensor, or some other cause. Select the bias value you want on the input designated.
FILTER 1	0 to 120 seconds No filter = 0	**FILTER FOR INPUT 1** - A software digital filter is provided for the input designated to smooth the input signal. You can configure the first order lag time constant from 1 to 120 seconds. If you do not want filtering, enter 0.

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4.8 Input 1 Parameters Set Up Group, Continued

Table 4-7 Input 1 Group definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
BURNOUT1		BURNOUT PROTECTION (SENSOR BREAK) provides most input types with upscale or downscale protection if the input fails. 1-5V, 0-10V, or 4-20mA inputs require no burnout or "NONE" selection.
	NONE	NO BURNOUT — Pre-configured Failsafe output applied if failed input is detected. Error message "INPUT1 FAIL" is flashed on the lower display intermittently every 10 seconds.
	UP	UPSCALE BURNOUT will make the PV signal increase to full scale when a sensor fails, and flash "INPUT1 FAIL" on the lower display intermittently every 10 seconds. The controller remains in Automatic control mode and adjusts the controller output signal in response to the full scale PV signal developed by the Burnout circuitry.
	DOWN	DOWNSCALE BURNOUT will make the PV signal decrease to the lower range value when a sensor fails, and flash "INPUT1 FAIL" on the lower display intermittently every 10 seconds. The controller remains in Automatic control mode and adjusts the controller output signal in response to the zero percent PV signal developed by the Burnout circuitry.
		NOTE: For no Burnout, i.e. "None," to function properly on a 4-20MA input, there must be a dropping resistor directly across the *input* terminals (i.e., not remote), then the unit can detect the "zero" voltage that occurs when the 4-20 mA line is opened.
EMISSIV1	0.01 to 1.00	EMISSIVITY is a correction factor applied to the Radiamatic input signal that is the ratio of the actual energy emitted from the target to the energy which would be emitted if the target were a perfect radiator. Available only for "Radiamatic" inputs.

4.9 Input 2 Parameters Set Up Group

Introduction

These are the parameters required for input 2: actuation. transmitter characterization, high and low range values in engineering units, Ratio, Bias, Filter, Burnout and Emissivity.

Input 2 group prompts

Table 4-8 lists all the function prompts in the Input 2 setup group and their definitions.

Table 4-8 Input 2 Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
IN 2TYP		**INPUT 2 ACTUATION TYPE** – This selection determines what actuation you are going to use for input two.
	B TC	B thermocouple 105 to 3300°F 41 to 1816°C
	E TC H	E thermocouple high –454 to 1832°F –270 to 1000°C
	E TC L	E thermocouple low –200 to 1100°F –129 to 593°C
	J TC H	J thermocouple high 0 to 1600°F –18 to 871°C
	J TC L	J thermocouple low 20 to 770°F –7 to 410°C
	K TC H	K thermocouple high 0 to 2400°F –18 to 1316°C
	K TC L	K thermocouple low –20 to 1000°F –29 to 538°C
	NNM H	NiNiMo thermocouple high 32 to 2500°F 0 to 1371°C
	NNM L	NiNiMo thermocouple low 32 to 1260°F 0 to 682°C
	NIC TC	Nicrosil-Nisil thermocouple 0 to 2372°F –17.8 to 1300°C
	R TC	R thermocouple 0 to 3100°F –18 to 1704°C
	S TC	S thermocouple 0 to 3100°F –18 to 1704°C
	T TC H	T thermocouple high –300 to 700°F –184 to 371°C
	T TC L	T thermocouple low –200 to 600°F –129 to 316°C
	W TC H	W5W26 thermocouple high 0 to 4200°F –18 to 2316°C
	W TC L	W5W26 thermocouple low 0 to 2240°F –18 to 1227°C
	100 PT	100 Ohm–RTD –300 to 900°F –184 to 482°C
	100 LO	100 Ohm RTD low 0 to 300°F –18 to 149°C
	200PT	200 Ohm - RTD –300 to 900°F –184 to 482°C
	500 PT	500 Ohm–RTD –300 to 1200°F –184 to 649°C
	RADIAM	Radiamatic (RH) 1400 to 3400°F 760 to 1871°C
	4-20mA	4 to 20 Milliamps
	10M	0 to 10 Millivolts
	10-50M	10 to 50 Millivolts
	0-5	0 to 5 Volts
	1-5 V	1 to 5 Volts
	0-10 V	0 to 10 Volts
	CARBON	
	OXYGEN	

Table 4-8 continued on next page

4.9 Input 2 Parameters Set Up Group, Continued

Table 4-8 Input 2 Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
XMITTER 2	B TC, S TC, E TC H, T TC H, E TC L, T TC L, J TC H, W TC H, J TC L, W TC L, K TC H, 100 PT, K TC L, 500 PT, NNM H, 100 LO, NNM L, 200PT, NIC TC, LINEAR, R TC, SQROOT	TRANSMITTER CHARACTERIZATION — This selection lets you instruct the controller to characterize a linear input to represent a non-linear one. NOTE: Prompt only appears when a linear actuation is selected at prompt "IN2 TYPE". FOR EXAMPLE: If input 1 is a 4 to 20 mA signal, but the signal represents a type "K" thermocouple; select "K TC H" and the controller will characterize the 4 to 20 mA signal so that it is treated as a type "K" thermocouple input (high range). Parameter definitions are the same as shown in Lower Display Prompt "IN2 TYPE"
IN2 HI	−999 to 9999 in Engineering units	INPUT 2 HIGH RANGE VALUE in engineering units is displayed for Input 2 but can only be configured for linear or square root only. Scale the #2 input signal to the display value you want for 100%.
IN2 LO	−999 to 9999 in Engineering units	INPUT 2 LOW RANGE VALUE in engineering units is displayed for Input 2 but can only be configured for linear or square root,only. Scale the #2 input signal to the display value you want for 0%.
RATIO 2	−20.00 TO +20.00	INPUT 2 RATIO VALUE - Used when Input 2 operates as a remote setpoint, prompt "RSP". This ratio value can be applied to the remote setpoint. It establishes the correct relationship between the remote setpoint and the Input 2 signal applied according to the formula: (RATIO x INPUT 2)+ BIAS = REMOTE SETPOINT
BIAS UNIT	ENGR PCT	BIAS UNITS - expressed in: ENGR - Engineering Units PCT - Percent
BIAS IN2	−999 to 9999 in Engineering units	INPUT 2 BIAS VALUE - Used when Input 2 operates as a remote setpoint, prompt "RSP". Bias, together with ratio, establishes the correct relationship between the remote setpoint and the Input 2 signal applied according to the formula: (RATIO x INPUT 2)+ BIAS = REMOTE SETPOINT
FILTER 2	0 to 120 seconds No filter = 0	FILTER FOR INPUT TWO — A software digital filter is provided for Input 2 to smooth the input signal. You can configure the first order lag constant from 1 to 120 seconds. If you do not want filtering, enter 0.

Table 4-8 continued on next page

4.9 Input 2 Parameters Set Up Group, Continued

Table 4-8 Input 2 Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
BURNOUT2		**BURNOUT PROTECTION (SENSOR BREAK)** - provides all input types with upscale or downscale protection if the input fails.
	NONE	**NO BURNOUT** - Failsafe output applied for failed input but not out of range.
	UP	**UPSCALE BURNOUT** - will make the indicated PV signal increase when a sensor fails, and flash in the upper display. Do not use for Linear Input.
	DOWN	**DOWNSCALE BURNOUT** - will make the indicated PV signal decrease when a sensor fails, and flash the upper display. Do not use for Linear Input.
EMISSIV 2	0.01 to 1.00	**EMISSIVITY FOR (RH) RADIAMATIC INPUTS** - A radiamatic pyrometer converts radiant energy emitted by a target into electrical energy. Emissivity is a correction factor applied to the radiamatic input signal that is the ratio of the actual energy emitted from the target to the energy which would be emitted if the target were a perfect radiator. Only available on Input 2 "RH" Radiamatic.

4.10 Input 3 Parameters Setup Group

Introduction

These are the parameters required for input 3: transmitter characterization, high and low range values in engineering units, Ratio, Bias, and Filter.

Input 2 group prompts

Table 4-9 lists all the function prompts in the Input 3 setup group and their definitions.

Table 4-9 Input 3 Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
XMITTER 3	B TC S TC E TC H T TC H E TC L T TC L J TC H W TC H J TC L W TC L K TC H 100 PT K TC L 500 PT NNM H 100 LO NNM L 200PT NIC TC LINEAR R TC SQROOT	TRANSMITTER CHARACTERIZATION — This selection lets you instruct the controller to characterize a linear input to represent a non-linear one. FOR EXAMPLE: If input 1 is a 4 to 20 mA signal, but the signal represents a type "K" thermocouple: select "K TC H" and the controller will characterize the 4 to 20 mA signal so that it is treated as a type "K" thermocouple input (high range).
IN3HI	–999 to 9999 in Engineering units	INPUT 3 HIGH RANGE VALUE in engineering units is displayed for input 3 but can only be configured for linear or square root only. Scale the #3 input signal to the display value you want for 100%.
IN3LO	–999 to 9999 in Engineering units	INPUT 3 LOW RANGE VALUE in engineering units is displayed for input 3 but can only be configured for linear or square root,only. Scale the #3 input signal to the display value you want for 0%.
RATIO 3	–20.00 TO +20.00	INPUT 3 RATIO VALUE - used when input 3 operates as a remote setpoint. This ratio value can be applied to the remote setpoint. It establishes the correct relationship between the remote setpoint and the input 3 signal applied according to the formula: (RATIO x INPUT 3) + BIAS = SETPOINT
BIAS IN3	–999 to 9999 in Engineering units	INPUT 3 BIAS VALUE - used when input 3 operates as a remote setpoint. Bias, together with Ratio establishes the correct relationship between the remote setpoint and the input 3 signal applied according to the formula: (RATIO x INPUT 3) + BIAS = SETPOINT
FILTER 3	0 to 120 seconds No filter = 0	FILTER FOR INPUT 3 — A software digital filter is provided for input 3 to smooth the input signal. You can configure the first order lag constant from 1 to 120 seconds. If you do not want filtering, enter 0.

4.11 Control Parameters Set Up Group

Introduction

The functions listed in this group deal with how the Single Loop Process Controller or Loop 1 of a Two Loop Process controller will control the process including: Number of tuning parameter sets, Setpoint source, Tracking, Power-up recall, Setpoint limits, Output direction, rate and limits, Dropoff, Deadband and Hysteresis.

Control group prompts

Table 4-10 lists all the function prompts in the Control setup group and their definitions.

Table 4-10 Control Group Definitions

Lower Display Prompt	Upper Display Range or Setting or Selection	Parameter Definition
PID SETS		**NUMBER OF TUNING PARAMETER SETS** — This selection lets you choose one or two sets of tuning constants (gain, rate, and reset).
	1 ONLY	**ONE SET ONLY** — Only one set of tuning parameters is available. Configure the values for: Gain (proportional band), Rate, Reset Time, and Cycle Time (if time proportional is used).
	2KEYBD	**TWO SETS KEYBOARD SELECTABLE** — Two sets of tuning parameters can be configured and can be selected at the operator interface or by using the Digital Inputs. Press [LOWR DISP] key until you see "PID SET1" or "PID SET2" to switch between sets. Configure the values for: Gain, Rate, Reset, Cycle Time Gain #2, Rate #2, Reset#2, Cycle#2 Time See Subsection 5.10 for procedure.
	2PV SW	**TWO SETS PV AUTOMATIC SWITCHOVER** — When the process variable is *GREATER* than the value set at prompt "SW VALUE" (Switchover Value), the controller will use Gain, Rate, Reset, and Cycle Time. The active PID SET can be read in the lower display. When the process variable is *LESS* than the value set at prompt "SW VALUE," the controller will use Gain #2, Rate #2, Reset #2, and Cycle #2 Time. The active PID SET can be read in the lower display. Other prompts affected: SW VALUE
	2SP SW	**TWO SETS SP AUTOMATIC SWITCHOVER** — When the setpoint is *GREATER* than the value set at prompt "SW VALUE" (Switchover Value), the controller will use Gain, Rate, Reset, and Cycle. When the setpoint is *LESS* than the value set at prompt "SW VALUE," the controller will use Gain #2, Rate #2, Reset #2, and Cycle #2. Other prompts affected: SW VALUE

Table 4-10 continued on next page

Table 4-10 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SW VALUE	Value in engineering units	**AUTOMATIC SWITCHOVER VALUE** —This is the value of Process Variable or Setpoint at which the controller will switch from Tuning Constant Set #2 to Set #1. Only appears when PID SETS selections "2PV SW" or "2SP SW" are selected.
LSP's		**LOCAL SETPOINT SOURCE** — This selection determines what your local setpoint source will be: One local or Two local. Toggled by [SP1/SP2] key.
	1ONLY	**LOCAL SETPOINT** — The setpoint entered from the keyboard.
	TWO	**TWO LOCAL SETPOINTS** — This selection lets you switch between two local setpoints using the [SP1/SP2] key.
	THREE	**THREE LOCAL SETPOINTS** — Setpoint 3 toggled by [RSP] key. LSP 3 is mutually exclusive with RSP or Internal Cascade.
RSP SOURC		**REMOTE SETPOINT SOURCE** — this selection determines what your remote setpoint source will be when toggled by the [RSP] key or Digital Input.
	NONE	**NONE** - No remote setpoint
	IN 2	**IN 2** - Remote Setpoint using Input 2 toggled by the [RSP] key (not available for 2loops or cascade units)
	IN 3	**IN 3** - Remote Setpoint using Input 3 toggled by the [RSP] key
AUTO BIAS		**AUTO BIAS** — is used for bumpless transfer when transferring from local setpoint to remote setpoint. Auto Bias calculates and adds a bias to remote setpoint input each time a transfer is made.
	ENABLE DISABLE	**ENABLE** -enables auto bias **DISABLE** - disable auto bias.
SP TRACK		**SETPOINT TRACKING** — The local setpoint can be configured to track either PV or RSP as listed below:
	NONE	**NO TRACKING** — If local setpoint tracking is not configured, the LSP will not be altered when transfer from RSP to LSP is made.
	PV	**PV** - Local setpoint tracks the PV when in manual.
	RSP	**RSP** - Local setpoint tracks remote setpoint. When the controller transfers out of remote setpoint, the last value of the remote setpoint (RSP) is inserted into the local setpoint.

Table 4-10 continued on next page

Table 4-10 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PWR MODE		**POWER UP CONTROLLER MODE RECALL** — This selection determines which mode and setpoint the controller will use when the controller restarts after a power loss. Select one from below:
	MANUAL	**MANUAL, LSP** — At power-up, the controller will use *manual* mode with the local setpoint displayed.
	A M SP	**LAST MODE/LAST SETPOINT** used before power down.
	AM LSP	**LAST MODE/LAST LOCAL SETPOINT** on power down.
PWR OUT		**POWER UP OUTPUT SELECTION** - This selection determines what output the controller will go to upon power up.
	LAST F'SAFE	LAST - Last output prior to power down F'SAFE - Failsafe Output
SP HILIM	0 to 100% of span input in engineering units with decimal place	**SETPOINT HIGH LIMIT*** — This selection prevents the local and remote setpoints from going above the value selected here. The setting must be equal to or less than the upper range of the inputs.
SP LOLIM	0 to 100% of span input in engineering units with decimal place	**SET POINT LOW LIMIT*** — This selection prevents the local and remote setpoints from going below the value selected here. The setting must be equal to or greater than the lower range of the inputs.
*The Local Setpoint will automatically adjust itself to be within the setpoint limit range. For example, if SP = 1500 and the SP HILIM is changed to 1200, the new Local Setpoint will be 1200.		
ACTION		**CONTROL OUTPUT DIRECTION** — In what direction do you want the controller output to go when the process variable increases.
	DIRECT	**DIRECT ACTING CONTROL** — The controller's output increases as the process variable increases.
	REVERSE	**REVERSE ACTING CONTROL** — The controller's output decreases as the process variable increases.
OUT HI LIM	-5.0 to 105.0% of output	**HIGH OUTPUT LIMIT** — This is the highest value of output beyond which you do not want the controller automatic output to exceed. Use 0 to 100% for Time Proportional output type. Use 5 to 105% for current output.

Table 4-10 continued on next page

Table 4-10 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
OUT LO LIM	–5.0 to 105.0% of output	LOW OUTPUT LIMIT — This is the lowest value of output below which you do not want the controller automatic output to exceed. Use 0 to 100% for Time Proportional output type. Use 5 to 105% for current output.
I HI LIM	Within the range of the output limits	HIGH RESET LIMIT - this is the highest value of output beyond which you want no reset to occur.
I LOLIM	Within the range of the output limits	LOW RESET LIMIT - this is the lowest value of output beyond which you want no reset to occur.
DROPOFF	–5 to 105.0% of output	CONTROLLER DROPOFF VALUE — output value that below which the controller output will dropoff to the low output limit value set in prompt "OUT LOLIM."
DEADBAND	 –5.0 to 25.0% 0 to 25.0%	DEADBAND is an adjustable gap between the operating ranges of output 1 and output 2 in which neither output operates (positive value) or both outputs operate (negative value). Duplex all others
OUT HYST	0.0 to 5.0% of PV span for ON/OFF control	HYSTERESIS (OUTPUT RELAY ONLY) - is an adjustable overlap of the ON/OFF states of each control relay. This is the difference between the value of the process variable at which the control relay(s) energize and the value at which they de-energize. Only applicable for ON/OFF control.
FAILSAFE	0 to 100%	FAILSAFE OUTPUT VALUE — The value used here will also be the output level when you have Communications SHED or when NO BURNOUT is configured and input 1 fails.

Table 4-10 continued on next page

4.11 Control Parameters Set Up Group, Continued

Table 4-10 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PROP BDor GAIN*		**PROPORTIONAL BAND UNITS** — Select one of the following for the Proportional (P) term of the PID algorithm:
	PROP BD	**PROPORTIONAL BAND** — Selects units of percent proportional band for the P term of the PID algorithm. Where: $PB\% = \frac{100\%FS}{GAIN}$
	GN	**GAIN** selects the unitless term of gain for the P term of the PID algorithm. Where: $GAIN = \frac{100\%FS}{PB\%}$
MINorRPM*		**RESET UNITS** — Selects units of minutes or repeat per minutes for the I term of the PID algorithm. 20 Repeats per Minute = 0.05 Minutes per Repeat.
	RPM	**REPEATS PER MINUTE** — The number of times per minute that the proportional action is repeated by reset.
	MIN	**MINUTES PER REPEAT** — The time between each repeat of the proportional action by reset.

*Selection here is used for both Loop 1 and Loop 2 if available.

4.12 Control2 Parameters Set Up Group

Introduction

The functions listed in this group deal with how **Loop 2** of a Two Loop Process controller will control the process including: PV Source, Number of tuning parameter sets, Setpoint source, Tracking, Power-up recall, Setpoint limits, Output direction, Rate and limits, Dropoff, Deadband and Hysteresis.

Control2 group prompts

Table 4-11 lists all the function prompts in the Control2 setup group and their definitions.

Table 4-11 Control2 Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PV2 SRC	 INPUT 1 INPUT 2 INPUT 3	**PROCESS VARIABLE2 SOURCE** - select the source of the Process Variable for Loop 2. INPUT 1 INPUT 2 INPUT 3
PID SETS		**NUMBER OF TUNING PARAMETER SETS** — This selection lets you choose one or two sets of tuning constants (gain, rate, and reset).
	1 ONLY	**ONE SET ONLY** — Only one set of tuning parameters is available. Configure the values for: Gain (proportional band) Rate Reset Time Cycle Time (if time proportional is used)
	2KEYBD	**TWO SETS KEYBOARD SELECTABLE** — Two sets of tuning parameters can be configured and can be selected at the operator interface or by using the Digital Inputs. Press [LOWR DISP] key until you see "PID SET3" or "PID SET4" to switch between sets. Configure the values for: Gain#3, Rate#3 , Reset#3, Cycle3Time Gain #4, Rate #4, Reset#4, Cycle#4 Time See Subsection 5.10 for procedures.
	2PV SW	**TWO SETS PV AUTOMATIC SWITCHOVER** — When the process variable is *GREATER* than the value set at prompt "SW VALUE" (Switchover Value), the controller will use Gain3, Rate3, Reset3, and Cycle 3Time. The active PID SET can be read in the lower display. When the process variable is *LESS* than the value set at prompt "SW VALUE," the controller will use Gain #4, Rate #4, Reset #4, and Cycle #4 Time. The active PID SET can be read in the lower display. Other prompts affected: SW VALUE

Table 4-11 continued on next page

Table 4-11 Control2 Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PID SETS (CONTINUED	2SP SW	TWO SETS SP AUTOMATIC SWITCHOVER — When the setpoint is *GREATER* than the value set at prompt "SW VALUE" (Switchover Value), the controller will use Gain3, Rate3, Reset3, and Cycle3. When the setpoint is *LESS* than the value set at prompt "SW VALUE," the controller will use Gain #4, Rate #4, Reset #4, and Cycle #4. Other prompts affected: SW VALUE
SW VALUE	Value in engineering units	AUTOMATIC SWITCHOVER VALUE —This is the value of Process Variable or Setpoint at which the controller will switch from Tuning Constant Set #4 to Set #3. Only appears when PID SETS selections "2PV SW" or "2SP SW" are selected.
LSP's		LOCAL SETPOINT SOURCE — This selection determines what your local setpoint source will be; One local or Two local. Toggled by the [SP1/SP2] key.
	1ONLY	LOCAL SETPOINT — The setpoint entered from the keyboard.
	TWO	TWO LOCAL SETPOINTS — This selection lets you switch between two local setpoints using the [SP1/SP2] key.
	THREE	THREE LOCAL SETPOINTS — Setpoint 3 toggled by [SP1/SP2] key. LSP 3 is mutually exclusive with RSP or Internal Cascade.
RSP SOURC		REMOTE SETPOINT SOURCE — this selection determines what your remote setpoint source will be when toggled by the [RSP] key.
	NONE IN 3 IN 2	NONE - No remote setpoint IN 3 - Remote Setpoint using Input 3 toggled by [RSP] key. IN 2 - Remote Setpoint using Input 2 toggled by [RSP] key.

Table 4-11 continued on next page

4.12 Control2 Parameters Set Up Group, Continued

Table 4-11 Control2 Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
AUTO BIAS		AUTO BIAS — is used for bumpless transfer when transferring from local setpoint to remote setpoint. Auto Bias calculates and adds a bias to remote setpoint input each time a transfer is made.
	ENABLE DISABLE	ENABLE -enables auto bias DISABLE - disable auto bias.
SP TRACK		SETPOINT TRACKING — The local setpoint can be configured to track either PV or RSP as listed below:
	NONE	NO TRACKING — If local setpoint tracking is not configured, the LSP will not be altered when transfer from RSP to LSP is made.
	PV	PV - Local setpoint tracks the PV when in manual.
	RSP	RSP - Local setpoint tracks remote setpoint. When the controller transfers out of remote setpoint, the last value of the remote setpoint (RSP) is inserted into the local setpoint.
PWR MODE		POWER UP CONTROLLER MODE RECALL — This selection determines which mode and setpoint the controller will use when the controller restarts after a power loss. Select one from below:
	MANUAL	MANUAL, LSP — At power-up, the controller will use *manual* mode with the local setpoint displayed.
	A M SP	LAST MODE/LAST SETPOINT used before power down.
	AM LSP	LAST MODE/LAST LOCAL SETPOINT on power down.
PWR OUT		POWER UP OUTPUT SELECTION - This selection determines what output the controller will go to upon power up.
	LAST F'SAFE	LAST - Last output prior to power down F'SAFE - Failsafe Output
SP HILIM	0 to 100% of span input in engineering units with decimal place	SETPOINT HIGH LIMIT* — This selection prevents the local and remote setpoints from going above the value selected here. The setting must be equal or less than the upper range of the inputs.
SP LOLIM	0 to 100% of span input in engineering units with decimal place	SET POINT LOW LIMIT* — This selection prevents the local and remote setpoints from going below the value selected here. The setting must be equal to or greater than the lower range of the inputs.

*The Local Setpoint will automatically adjust itself to be within the setpoint limit range. For example, if SP = 1500 and the SP HILIM is changed to 1200, the new Local Setpoint will be 1200.

Table 4-11 continued on next page

Table 4-11 Control2 Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
ACTION		**CONTROL OUTPUT DIRECTION** — In what direction do you want the controller output to go when the process variable increases.
	DIRECT	**DIRECT ACTING CONTROL** — The controller's output increases as the process variable increases.
	REVERSE	**REVERSE ACTING CONTROL** — The controller's output decreases as the process variable increases.
OUT HI LIM	–5.0 to 105.0% of output	**HIGH OUTPUT LIMIT** — This is the highest value of output beyond which you do not want the controller automatic output to exceed. Use 0 to 100% for digital output type. Use 5 to 105% for current output.
OUT LO LIM	–5.0 to 105.0% of output	**LOW OUTPUT LIMIT** — This is the lowest value of output below which you do not want the controller automatic output to exceed. Use 0 to 100% for digital output type. Use 5 to 105% for current output.
I HI LIM	Within the range of the output limits	**HIGH RESET LIMIT** - this is the highest value of output beyond which you want no reset to occur.
I LOLIM	Within the range of the output limits	**LOW RESET LIMIT** - this is the lowest value of output beyond which you want no reset to occur.
DROPOFF	–5 to 105.0% of output	**CONTROLLER DROPOFF VALUE** — output value that below which the controller output will dropoff to the low output limit value set in prompt "OUT LOLIM."
DEADBAND		**DEADBAND** is an adjustable gap between the operating ranges of output 1 and output 2 in which neither output operates (positive value) or both outputs operate (negative value).
	–5.0 to 25.0%	Time Duplex
	0 to 25.0%	On-Off Duplex
FAILSAFE	0 to 100%	**FAILSAFE OUTPUT VALUE** — The value used here will also be the output level when you have Communications SHED or when NO BURNOUT is configured and input 1 fails.

4.13 Options Set Up Group

Introduction

Configure the Digital Input to a specific contact closure response, or configure the Auxiliary Output to be a specific selection with desired scaling.

Table 4-12 lists all the function prompts in the "OPTION" setup group and their functions.

Table 4-12 Option Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
AUX OUT		**AUXILIARY OUTPUT** - can represent one of seven control parameters. The display for auxiliary output viewing will be in engineering units for all but output. Output will be in percent. Other prompts affected by these selections: "4mA VAL" and "20mA VAL."
	DISABL	**NO AUXILIARY OUTPUT**
	IN 1	**INPUT 1** represents the value of the configured range of input 1.
	IN 2	**INPUT 2** represents the value of the configured range of input 2.
	IN 3	**INPUT 3** represents the value of the configured range of input 3.
	PV	**PROCESS VARIABLE** — Represents the value of the Process Variable.
	DEV	**DEVIATION (PROCESS VARIABLE MINUS SETPOINT)** — Represents –100 to +100% of the selected PV span in engineering units for Loop 1.. When Deviation is selected, only one operating parameter will be entered. This value represents the deviation level that will produce 20mA output. Zero deviation will produce a center scale (12mA) output. A negative deviation equal in magnitude to the 2nd current output high value will produce a low end (4mA) output.
	OUTPUT	**OUTPUT** — Represents the displayed controller output in percent (%) for Loop 1.
	SP	**SETPOINT** — Represents the value of the setpoint in units of PV for Loop 1.

Table 4-12 continued on next page

4.13 Options Set Up Group, Continued

Table 4-12 Option Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
AUXOUT (continued)	PV 2	**PROCESS VARIABLE** — Represents the value of the Process Variable for Loop 2.
	DEV 2	**DEVIATION 2 (PROCESS VARIABLE MINUS SETPOINT)** — Represents –100 to +100% of the selected PV span in engineering units for Loop 2. When Deviation is selected, only one operating parameter will be entered. This value represents the deviation level that will produce 20mA output. Zero deviation will produce a center scale (12mA) output. A negative deviation equal in magnitude to the 2nd current output high value will produce a low end (4mA) output.
	OUT2	**OUTPUT 2** — Represents the displayed controller output in percent (%) for Loop 2.
	SP 2	**SETPOINT 2**— Represents the value of the setpoint in units of PV for Loop 2.
4mA VAL	Low Scale Value within the range of the selected variable to represent 4 mA	**AUXILIARY OUTPUT LOW SCALING FACTOR** — Use a value in engineering units to represent all above except output. Use value in percent (%) for Output. (Output can be between –5 and +105%.)
20mA VAL*	High Scale Value within the range of the selected variable to represent 20 mA	**AUXILIARY OUTPUT HIGH SCALING FACTOR** — Use a value in engineering units to represent all above except output. Use a value in percent (%) for Output. (Output can be between –5 and +105%.) *When Deviation is selected, only one operating parameter will be entered. This value represents the deviation level that will produce 20 mA output. Zero deviation will produce a center scale (12 mA) output. A negative deviation equal in magnitude to the Auxiliary Output High Value will produce a low end (4 mA) output.
REM SW1		**DIGITAL INPUT ONE SELECTION** - Contact closure enables one of the following (applies to Loop 1 on 2 Loop models). The controller returns to its original state when contact opens, except when overruled by the keyboard. ATTENTION If the controller is configured for "Cascade" or "2 Loop" control, switch #1 operates only Loop 1; switch 2 operates only on Loop 2.
	NONE	**NO DIGITAL INPUT SELECTIONS**
	To MAN	**TO MANUAL** — Contact closure puts the controller into manual mode.

Table 4-12 continued on next page

4.13 Options Set Up Group, continued

Table 4-12 Option Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
REM SW1 continued		
	To SP1	**TO LOCAL SETPOINT** — Contact closure puts the controller into local setpoint 1.
	To SP2	**TO LOCAL SETPOINT TWO** — Contact closure puts the controller into local setpoint 2.
	To DIR	**TO DIRECT ACTION** — Contact closure selects direct controller action.
	ToHOLD	**TO HOLD** — Contact closure suspends Setpoint Ramp/Program. Contact open runs ramp/program.
	ToPID2	**TO PID2** — Contact closure selects PID Set 2.
	PV IN2 *	**PV = INPUT 2**-Contact Closure selects PV = Input 2.
	PV IN3 *	**PV = INPUT 3**-Contact Closure selects PV = Input 3.
	To RUN	**RUN** — Contact closure starts a stopped SP RAMP.
	To BGN	**TO BEGIN** — Resets the SP Program to the setpoint at the beginning of the program without any change in mode or program status.
REM SW2		**DIGITAL INPUT TWO SELECTIONS** — Same selections as REM SW1. Digital Input 2 is reserved for Loop 2 parameters when Two Loops or Internal Cascade is configured. ATTENTION Digital Input #1 has priority over Digital Input #2.

* When an input combination algorithm has been selected, selections PV IN2 and PV IN3 will result in the "PV LIMIT" error message. For example, selecting Carbon Potential as the second input algorithm will not permit selection "PV INPUT 2" to function.

4.14 Communications Set Up Group

Introduction

This option allows the controller to be connected to a host computer via a RS422/485 or DMCS bus.
Thirty-one units (DMCS) or Fifteen units (RS422) can be configured over this link.
The controller looks for messages from the computer at regular intervals. If these messages are not received within the configured shed time, the controller will SHED from the communications link and return to stand alone operation. The Device address, Parity, Baud rate, Computer Setpoint, Units, Ratio, and Bias are configurable depending on the protocol you are using.
You can also set the SHED output mode and setpoint recall and communication units.

Communications group prompts

Table 4-13 lists all the function prompts in the Communications setup group and their definitions.

Table 4-13 Communications Group Definitions

Lower Display Prompt	Upper Display/ Range of Setting or Selection	Parameter Definition
ComSTATE	DISABL DMCS RS-422/485	COMMUNICATIONS SELECTION DISABL — Disables the communications option. DMCS — Allows DMCS communication prompts. RS-422/485 — Allows RS422/485 communication prompts.
ComADDR	1 to 31 (DMCS) 1 to 99 (RS422)	COMMUNICATIONS STATION ADDRESS (LOOP 1) — This is a number that is assigned to a controller that is to be used with the communications option. This number will be its address. Must be different addresses for 2 Loops on RS422/485.
ComADDR2	1 to 31 (DMCS) 1 to 99 (RS422)	COMMUNICATIONS STATION ADDRESS (LOOP 2) — This is a number that is assigned to a controller that is to be used with the communications option. This number will be its address. Must be different addresses for 2 Loops on RS422/485.
SHEDTIME	0 to 255	SHED TIME — The number that represents how many sample periods there will be before the controller sheds from communications. Each period equals 1/3 seconds or 0 = No shed.
PARITY (RS422/485 only)	ODD EVEN	PARITY pertains to the use of a self-checking code employing binary digits in which the total number of ONE's (or ZERO's) in each permissible code expression is either ODD or EVEN. ODD PARITY EVEN PARITY

Table 4-13 continued on next page

Table 4-13 Communications Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
BAUD (RS422/485 only)		BAUD RATE is the transmission speed in bits per second.
	300	300 BAUD
	600	600 BAUD
	1200	1200 BAUD
	2400	2400 BAUD
	4800	4800 BAUD
	9600	9600 BAUD
	19200	19200 BAUD
SHEDMODE (DMCS only)		SHED CONTROLLER MODE AND OUTPUT LEVEL — determines the mode of local control you want when the controller is shed from the communications link.
	LAST	LAST -SAME MODE AS BEFORE SHED - The controller will return to the same mode (manual or automatic) that it was in before shed.
	TO MAN	TO MAN — TO MANUAL MODE BUMPLESS OUTPUT - The controller will return to manual mode at the same output level that it had before shed.
	FSAFE	FSAFE — TO MANUAL MODE, FAILSAFE OUTPUT - The controller will return to manual mode at the output value selected at "CONTROL" prompt "FAILSAFE".
	TO AUTO	TO AUTOMATIC MODE— The controller will return to automatic mode when the controller is shed from communications.
SHED SP (DMCS only)		SHED SP — Shed setpoint (DMCS only).
	TO LSP	TO LSP — Controller will use last local SP used.
	TO CSP	TO CSP — Controller will use computer setpoint.
UNITS		COMMUNICATION UNITS — This selection determines how the controller values are expressed during communications.
	PERCNT	PERCENT OF SPAN
	ENG UNITS	ENGINEERING UNITS
CSRATIO	–20.00 TO 20.00	LOOP 1 COMPUTER SETPOINT RATIO - Computer Setpoint ratio for Loop 1.
CS BIAS	–999.0 to 9999 Eu –999 to 2000% of CSP Span	LOOP 1 COMPUTER SETPOINT BIAS - Computer Setpoint Bias for Loop 1.
CSRATIO2	–20.00 TO 20.00	LOOP 2 COMPUTER SETPOINT RATIO - Computer Setpoint ratio for Loop 2.
CSBIAS2	–999.0 to 9999 Eu –999 to 2000% of CSP Span	LOOP 2 COMPUTER SETPOINT BIAS - Computer Setpoint Bias for Loop 2.

Continued on next page

4.14 Communications Set Up Group, Continued

Table 4-13 Communications Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
DMCS SW	 ULTRA 5000	**DMCS TYPE SELECTION** - Choose from the following: **ULTRA** - only UDC5000 Ultra-Pro databases accepted on downloads **5000** - All UDC5000 databases accepted on downloads.
LOOPBACK	 ENABLE DISABL	**LOCAL LOOPBACK** tests the communications hardware. **ENABLE** — Allows loopback test. The UDC goes into Loopback mode in which it sends and receives its own message. The UDC displays "PASS" or "FAIL" in the upper display and "LOOPTEST" in the lower display as long as the test is running. The UDC will go into manual mode. The test will run until the operator disables it here. **DISABLE** - disables the Loopback test.

4.15 Alarms Set Up Group

Introduction

An alarm is an indication that an event that you have configured (for example—Process Variable) has exceeded one or more alarm limits. There are two alarms available. Each alarm has two setpoints. You can configure each of these two setpoints to alarm on various controller parameters.

There are two alarm output selections, High and Low. You can configure each setpoint to alarm either High or Low.

Alarms group prompts

Table 4-14 lists all the function prompts in the Alarms setup group and their definitions.

Table 4-14 Alarms Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
A1S1 VAL	Value in Engineering Units	**ALARM 1 SETPOINT 1 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A1S1TYPE" to actuate. The value depends on what the setpoint has been configured to represent. NO setpoint is required for Communications SHED. ATTENTION For alarms configured for "EVENT", the value here is the segment number to which the event applies.
A1S2 VAL	Value in Engineering Units	**ALARM 1 SETPOINT 2 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A1S2TYPE" to actuate. The details are the same as "A1S1 VAL".
A2S1 VAL	Value in Engineering Units	**ALARM 2 SETPOINT 1 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A2S1TYPE" to actuate. The details are the same as "A1S1 VAL".
A2S2 VAL	Value in Engineering Units	**ALARM 2 SETPOINT 2 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A2S2TYPE" to actuate. The details are the same as "A1S1 VAL".

Table 4-14 continued on next page

Table 4-14 Alarms Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
A1S1TYPE	 NONE IN1 IN2 PV DEV OUTPUT SHED EV ON EV OFF IN3 PV2 DEV2 OUT2	**ALARM 1 SETPOINT 1 TYPE** — Select what you want Setpoint 1 of Alarm 1 to represent. NO ALARM INPUT 1 INPUT 2 PROCESS VARIABLE DEVIATION OUTPUT SHED FROM COMMUNICATIONS EVENT ON (SP PROGRAMMING) * EVENT OFF (SP PROGRAMMING) * INPUT 3 CONTROL LOOP 2 PV CONTROL LOOP 2 DEVIATION CONTROL LOOP 2 OUTPUT * Alarm configured for Events will not operate on setpoint program segments of "0" length ATTENTION When the Alarm type is reconfigured, the value of the current alarm setpoint does not automatically change to be consistent with the range of the new alarm type until it is viewed on the display.
A1S2TYPE	Same as A1S1 TYPE	**ALARM 1 SETPOINT 2 TYPE** — Select what you want Setpoint 2 of Alarm 1 to represent. The selections are the same as A1S1TYPE.
A2S1TYPE	Same as A1S1 TYPE	**ALARM 2 SETPOINT 1 TYPE** — Select what you want Setpoint 1 of Alarm 2 to represent. The selections are the same as A1S1TYPE. NOTE: Not applicable with Relay Duplex or Position Proportional outputs.
A2S2TYPE	Same as A1S1 TYPE	**ALARM 2 SETPOINT 2 TYPE** — Select what you want Setpoint 2 of Alarm 2 to represent. The selections are the same as A1S1TYPE. NOTE: Not applicable with Relay Duplex or Position Proportional outputs.
A1S1 H L	 HI LO	**ALARM 1 SETPOINT 1 STATE** — Select whether you want the alarm type chosen in Prompt "A1S1TYPE" to alarm High or Low. HI ALARM LO ALARM

Table 4-14 continued on next page

Table 4-14 Alarms Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
A1S1EV		ALARM 1 SETPOINT 1 EVENT - Select the beginning or end of a segment of ramp/soak programming for the alarm to activate.
	BEGIN END	BEGIN - alarm on the beginning of a segment END - alarm on the end of the segment
A1S2 H L		ALARM 1 SETPOINT 2 STATE — Select whether you want the alarm type chosen in Prompt "A1S2TYPE" to alarm High or Low.
	HI LO	HI ALARM LO ALARM
A1S2EV		ALARM 1 SETPOINT 2 EVENT - Select the beginning or end of a segment of ramp/soak programming for the alarm to activate.
	BEGIN END	BEGIN - alarm on the beginning of a segment END - alarm on the end of the segment
A2S1 H L		ALARM 2 SETPOINT 1 STATE — Select whether you want the alarm type chosen in Prompt "A2S1TYPE" to alarm HIGH or LOW.
	HI LO	HI ALARM LO ALARM
A2S1EV		ALARM 2 SETPOINT 1 EVENT - Select the beginning or end of a segment of ramp/soak programming for the alarm to activate.
	BEGIN END	BEGIN - alarm on the beginning of a segment END - alarm on the end of the segment
A2S2 H L		ALARM 2 SET POINT 2 STATE — Select whether you want the alarm type chosen in Prompt "A2S2TYPE" to alarm HIGH or LOW.
	HI LO	HI ALARM LO ALARM
A2S2EV		ALARM 2 SETPOINT 2 EVENT - Select the beginning or end of a segment of ramp/soak programming for the alarm to activate.
	BEGIN END	BEGIN - alarm on the beginning of a segment END - alarm on the end of the segment

Table 4-14 continued on next page

4.15 Alarms Set Up Group, Continued

Table 4-14 Alarms Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
AL HYST	0.0 to 5.0% of span or full output as appropriate	**ALARM HYSTERESIS** — A single adjustable hysteresis is provided on alarms such that when the alarm is OFF it activates at exactly the alarm setpoint; when the alarm is ON, it will not deactivate until the variable is 0.0% to 5.0% away from the alarm setpoint. Configure the hysteresis of the alarms based on INPUT signals as a % of input range span. Configure the hysteresis of the alarm based on OUTPUT signals as a % of the full scale output range.
ALM ACTN	 RLY ON RLY OFF	**ALARM RELAY COIL ACTION** - The alarm action is configurable for normally de-energized (Reverse) operation. RLY ON - Coil energized on alarm. RLY OFF - Coil de-energized on alarm.

4.16 Display Parameters Set Up Group

Introduction

This group contains selections for Decimal Place, Bargraph Representation, Units of Temperature, and Power Frequency.

Alarms group prompts

Table 4-15 lists all the function prompts in the Display setup group and their definitions.

Table 4-15 Display Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
DECIMAL	XXXX XXX.X XX.XX X.XXX	**DECIMAL POINT LOCATION** — This selection determines where the decimal point appears in the display. **XXXX** - No Decimal Place **XXX.X** - One Place **XX.XX** - Two Places **X.XXX** - Three Places
DECIMAL2	XXXX XXX.X XX.XX X.XXX	**CONTROL LOOP 2 DECIMAL POINT LOCATION** — This selection determines where the decimal point appears in the display for Loop 2. **XXXX** - No Decimal Place **XXX.X** - One Place **XX.XX** - Two Places **X.XXX** - Three Places
BARGRAPH	DEV OUTPUT DEV/OUT	**BARGRAPH REPRESENTATION** - Lets you select what you want the bargraph to represent. The bargraph normally shows Output when the lower display shows deviation or setpoint. **DEV** - Bargraph shows only Deviation **OUTPUT** - Bargraph shows Output **DEV/OUT** - Bargraph normally shows output when the lower display shows deviation or setpoint, otherwise the bargraph shows deviation.
UNITS	F C NONE	**TEMPERATURE UNITS** - This selection will affect the indication and operation. Applies to Loop 1. **F** - Degrees Fahrenheit **C** - Degrees Centigrade **NONE** - No display of units
UNITS 2	F C NONE	**CONTROL LOOP 2 TEMPERATURE UNITS** - This selection will affect the indication and operation. Applies to Loop 2. **F** - Degrees Fahrenheit **C** - Degrees Centigrade **NONE** - No display of units
PWR FREQ	60HZ 50HZ	**POWER FREQUENCY** - Select whether your controller is operating at 50 or 60 Hertz.

4.17 Calibration Data

Introduction

The prompts used here are for field calibration purposes. Refer to *Section 7 – Input Calibration* in this manual for complete information.

4.18 Status Test Data

Introduction

The prompts used here are for determining the reason for a controller failure. Refer to the *Section 9– Troubleshooting* in this manual for complete information.

Section 5 – Operation

5.1 Overview

Introduction

This section gives you all the information necessary to monitor and operate your controller. Review the Operator Interface shown in subsection 5.4 "Monitoring" to make sure you are familiar with the display and indicator definitions. The key functions are listed in *Section 1 - Overview.*

What's in this section?

This section contains the following topics:

5.2 How to Power Up The Controller

Apply power

When power is applied, the controller will run three diagnostic tests. All the displays will light and then the controller will go into automatic mode.

Diagnostic tests

Table 5-1 lists the three diagnostic tests.

Table 5-1 Power Up Diagnostic Tests

Prompt on Lower Display	Condition
RAM TEST	Checks internal memory
CONFTEST	Checks the controller's software configuration for inconsistencies.
CAL TEST	Checks calibration of the controller's configured analog inputs and outputs.

Test failures

All the displays and indicators will light and then display "TEST DONE".
If all these tests pass, the controller will function in a normal manner without any diagnostic messages.
If one or more of these tests fail, the controller will go to the Fail-safe Manual Mode, and "FAILSAFE" will flash in the lower display.

Troubleshooting

Refer to "STATUS TESTS" in *Section 9- Troubleshooting* to identify and correct the problem.

Continued on next page

Check the displays and keys

Use the procedure in Table 5-2 to run the display and key test.

Table 5-2 Procedure for Testing the Displays and Keys

Press	Result
[SET UP] and hold in, then [FUNC] at the same time	The controller will run a display test. All the displays will light for 8 seconds, then the displays will look like this: Upper Display: KEYS Lower Display: TRY ALL You will have 60 seconds to test the keys.
Press each key to see if it works	When the key is pressed, the lower display will indicate the name of the key pressed.

Key Pressed	Lower Display
FUNC	FUNCTION
LOWR DISP	LOWR_DISP
MAN/AUTO	AUTO_MAN
AUTO TUNE	AUTOTUNE
SET UP	SETUP
▲	INCREMENT
▼	DECREMENT
RUN/HOLD	RUN_HOLD
ALM 1	ALARM_1
ALM 2	ALARM_2
REM SP	REMOTESP
SP1/SP2	SP1_SP2
▲+▼	INCR_DECR
FUNC+SETUP	FUNC SU
FUNC + ▲	FUNC_INCR

If no key is pressed for 20 seconds, the test will time out and the controller will go into control mode.

If any test fails, go to "Controller Failure Symptoms" in *Section 9-Troubleshooting*.

Key error

When a key is pressed and the prompt "KEY ERROR" appears in the lower display, it will be for one of the following reasons:

- parameter not available,
- not in Set Up mode, press [SET UP] key first,
- Key malfunction, do keyboard test.

5.3 Enter a Security Code

Introduction

The LOCKOUT feature in the UDC5000 is used to inhibit changes (via keyboard) of certain functions or parameters by unauthorized personnel. There are different levels of LOCKOUT depending on the level of security required. These levels are:

NONE
CALIB
+CONF
+VIEW
MAX

See *Section 4 - Configuration Definitions* for details.

Security code numbers

The level of keyboard lockout may be changed in the Set Up mode. However, knowledge of a security code number (1 to 4095) may be required to change from one level of lockout to another.
When a controller leaves the factory, it has a security code of 0 which permits changing from one lockout level to another without entering any other code number.

Procedure

If you require the use of a security code, select a number from 0001 to 4095 and enter it when the lockout level is configured as "NONE".
Thereafter, that selected number must be used to change the lockout level from something other than "NONE".

CAUTION Write the number on the Configuration Record Sheet in the configuration section so you will have a permanent record.

Use the procedure in Table 5-3 to enter a security code.

Table 5-3 Procedure for Entering a Security Code

Step	Press	Action
1	SET UP	Until you see Upper Display SET UP Lower Display TUNING
2	FUNC	Until you see Upper Display 0 Lower Display SECURITY
3	▲ or ▼	to enter a four digit number in the upper display (1 to 4095) This will be your security code.

5.4 Monitoring Your Controller

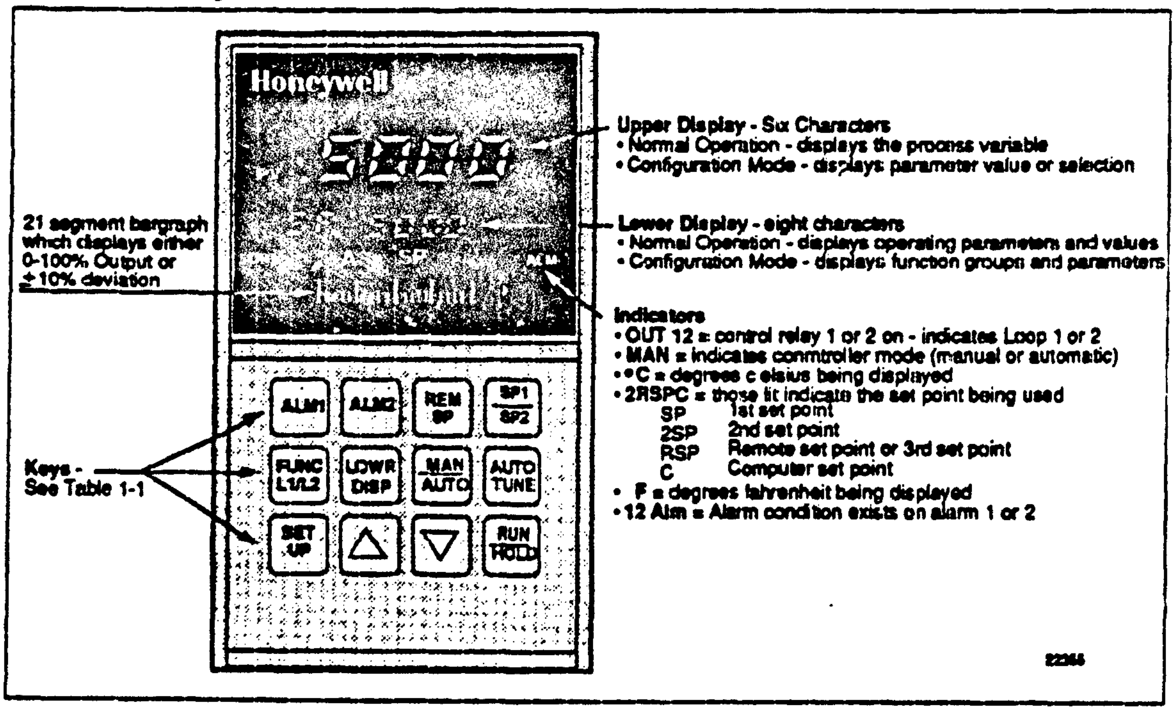
Operator Interface

The indicators and displays on the Operator Interface let you see what is happening to your process and how the controller is responding.

Figure 5-1 is a view of the Operator interface. A description of the displays and indicators is included.

When **Two Loop** or **Cascade** is configured, the left-most character shows "1" or "2" to indicate the loop being displayed.

Figure 5-1 Operator Interface



Decimal point position

In each display, when no decimal place is configured, the right-most character is blank.

When a single decimal position has been configured and values greater than 1000 are displayed, the right-most character is blank but the decimal point will be lit.

Continued on next page

Bargraph

In addition to the displays and indicators described in Figure 5-1, the Operator Interface contains a bargraph containing 21 discrete bars used to display Output, Deviation, or both depending on how it is configured.

OUTPUT	Each bar represents 5%, with 0% output at the left, and 100% output at the right The right hand arrow is always lighted.
DEVIATION	The center bar represents zero deviation. For deviations where the Process Variable (PV) is greater than the Setpoint, bars to the right of center light. When the PV is less than the setpoint, bars to the left of center light. The arrow [< or >] indicates that the deviation is greater than ±10%. Each bar represents 1% deviation, thus the bargraph covers a range of −10% to +10%.
DEVOUT	The bargraph is configured to display output and/or deviation depending on the lower display • When the value for setpoint or deviation is in the lower display, the bargraph represents Output. • When the value for other parameters are in the lower display, the bargraph represents deviation.

Monitoring Carbon Potential

DISPLAYS

When monitoring Carbon Potential, the displays will indicate the following:

Upper Display	indicates measured % Carbon (0–2.00%).
Lower Display	shows the current setpoint.

LOWER DISPLAY KEY

Pushing the $\boxed{\text{LOWR DISP}}$ key will enable viewing Input 1 - the probe temperature in °C or °F as configured, or the Carbon Probe millivolt signal (0–1250mv).

POTENTIAL SOOTING

If the furnace atmosphere based on carbon potential and temperature exceeds the approximate Austentite boundary and enters the potential sooting region, a "SOOTING" error message will be displayed for 3 seconds, every 10 seconds in the lower display.

Continued on next page

Viewing the operating parameters

Press the [LOWR DISP] key to scroll through the operating parameters listed in Table 5-4. The lower display will show only those parameters and values that apply to your specific model and the way it was configured.

There is a 60 second time-out if the [LOWR DISP] key is not pressed.

The [LOWR DISP] key is also used to return to normal control mode from the Setup mode.

Table 5-4 Lower Display Key Parameter Prompts

LOWER DISPLAY INDICATION (XXXX = Value)	DEFINITION	REMARKS
OUTXXX.X	OUTPUT	Displays the output value* When Position Proportional is installed and in automatic mode, the display represents the motor position. when the controller is configured for 3 Position Step control algorithm and no slidewire exists, it represents the estimated 3 Position Step Motor Position.
2OTXXX.X	OUTPUT #2	Appears only if 2 loop or Cascade is configured
SPXXXX	LOCAL SETPOINT #1	Also current setpoint if using SP Ramp or SP Programming **
2SPXXXX	LOCAL SETPOINT #2	Where RSP does not apply or for 2 loop applications**
RSPXXXX	REMOTE SETPOINT	Optional - when available or setpoint 3***
1INXXXX	INPUT 1	For input combination applications***
2INXXXX	INPUT 2	For input combination applications including Carbon Probe***
3INXXXX	INPUT 3	Optional - mutually exclusive with Position Proportional model***
CSPXXXX	COMPUTER SETPOINT	When SP is in override***
DEVXXXX	DEVIATION	Maximum negative display is –999.9***
PID SET X	TUNING PARAMETER SET 1	Selected set for single or primary loop configuration ; X = 1 or 2**
2PID SET X	TUNING PARAMETER SET 2	Selected set for single or secondary loop configuration where X = 3 or 4**
XXRAHH.MM	RAMP TIME	Time remaining in the setpoint ramp in hours (HH) and minutes (MM); XX=1 to 19***
XXSKHH.MM	SOAK TIME	Time remaining in the setpoint soak in hours (HH) and minutes (MM); XX=2 to 20***
RECYC X	CYCLES REMAINING	Number of cycles remaining in the setpoint program; X = 0 to 99
RAMPXXXM	SINGLE SETPOINT RAMP TIME	Time remaining in single setpoint ramp in minutes
SAM	SAMPLE NUMBER	Current sample number during Autotune data gathering***
1 PVXXXX	PROCESS VARIABLE 1	Process variable 1 for 2 loop or cascade applications
2 PVXXXX	PROCESS VARIABLE 2	Process variable 2 for 2 loop or cascade applications
POS	MOTOR POSITION	Three Position Step Motor Position when slidewire connected.

* The Output value can be changed in Manual mode only.

** The value can be changed using the [Raise/Lower] keys.

*** The value cannot be changed

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Diagnostic error messages

The UDC5000 performs background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed.

In the case of more than one simultaneous malfunctions, only the one with the highest priority will appear on the lower display.

A list of error messages is contained in Table 5-5.

If any of these error messages occur, refer to *Section 9 - Troubleshooting* for information to correct the failure.

Table 5-5 Error Messages

Prompt	Description
EE FAIL	Unable to write to non-volatile memory
NV FAIL	Unable to write RAM non-volatile memory
FAILSAFE	Failsafe
INP1FAIL	Two consecutive failures of input 1 integration
INP2FAIL	Two consecutive failures of input 2 integration
INP3FAIL	Two consecutive failures of input 3 integration
INP1 RNG	Input 1 out-of-range
INP2 RNG	Input 2 out-of-range
INP3 RNG	Input 3 out-of-range
SOOTING	Percent Carbon falls above "SOOTING BOUNDARY"
BATT LOW	Battery Voltage is below 2.125Vdc
RH LO	Calculated %RH is below 0%
PV LIMIT	PV ±10% out-of-range PV = INP1 + INP1 Bias Second input algorithm selection (for example: Carbon Potential) does not permit Remote Switching parameter selection of PVIN2 or PVIN3.
RV LIMIT	Remote Variable out-of-range Note: RV =(Input2 x Ratio) +Bias
SEG ERR	Start segment of setpoint program is > than the end segment number.
CONF ERR	• Low limit greater than high limit for PV, SP, Reset, or Output • Conflict between the remote mode switches and the input algorithm selection
SW FAIL	Position Proportioning Feedback Slidewire failure

5.5 Start Up Procedure

Procedure

The Start-up procedure is given in Table 5-6.

Table 5-6 Procedure for Starting Up the Controller

Step	Operation	Press	Action
1	Select manual mode	MAN AUTO	until "MAN" indicator is ON. The controller is in manual mode.
2	Adjust the output	▲ or ▼	to adjust the output value and ensure that the final control element is functioning correctly. Upper Display — shows the PV value Lower Display — shows OUT and the output value in %.
3	Tune the controller	SET UP	Make sure the controller has been configured properly and all the values and selections have been recorded on the Configuration Record Sheet. To tune your controller manually, see *Appendix A* . Refer to Set Up group "TUNING" to ensure that the proper selections for PROP BD or GAIN, RATE MIN, and RSET MIN or RSET RPM have been entered. For 2 Loop or Cascade control, refer to "TUNING L2" for tuning parameters. For controllers with ADAPTIVE TUNE or AUTOTUNE, see the procedures in this section.
4	Enter the local setpoint	LOWR DISP	Upper Display — shows the PV Value Lower Display — SP and the local setpoint value
		▲ or ▼	To adjust the local setpoint to the value at which you want the process variable maintained. The local setpoint cannot be changed if the Setpoint Ramp function is enabled. "H" or "R" appears in the upper display.
5	Select Automatic Mode	MAN AUTO	until "A" indicator is ON. The controller is in Automatic mode. The controller will automatically adjust the output to maintain the process variable at setpoint, if the controller is properly tuned.

5.6 Operating Modes

Available modes

The controller can operate in any of five basic modes:
- Manual
- Automatic with Local Setpoint
- Automatic with Remote Setpoint
- Manual (Cascade)
- Automatic (Cascade)

Manual and Automatic with Local set point are standard features and Automatic with Remote Setpoint is optional.

Mode definitions

Table 5-7 lists the five modes and their definitions.

Table 5-7 Operating Mode Definitions

Operating Mode	Definition
MANUAL	When switched to manual mode, the controller holds its output at the last value used during automatic operation and stops adjusting the output for changes in setpoint or process variable. Instead, you adjust the output by changing the value shown in the lower display. See *"Selecting Manual or Automatic"* in this subsection.
AUTOMATIC with LOCAL SETPOINT	In automatic local mode, the controller will operate from the local setpoint and automatically adjust the output to maintain the setpoint at the desired value. In this mode you can adjust the setpoint. See *Subsection 5.7 - "Setpoints"*.
AUTOMATIC with REMOTE SETPOINT	In automatic remote mode, the controller will operate from the setpoint measured at input 2. Adjustments are available to ratio this input and add a constant bias before it is applied to the control equation. See *Section 3 - Configuration, Set up group "Control"*. *Not available in CASCADE.*
MANUAL (CASCADE)	In the manual cascade mode, both control loops are in manual although there is only one output active. This mode is used to bring both loops into a reasonable operation area, at which point the unit is placed into the Automatic Cascade Mode.
AUTOMATIC (CASCADE)	In Automatic Cascade mode, there are two control loops, with one loop's output acting as the setpoint for the second control loop. There is only one physical output in this mode.

Continued on next page

What happens when you change modes

Table 5-8 explains what happens to the controller when you switch from one mode to another.

Table 5-8 Changing Operating Modes

Mode Change	Description
Manual to Automatic Local Setpoint	The local setpoint is usually the value previously stored as the local setpoint. PV Tracking is a configurable feature which modifies this. When it is selected, the local setpoint value tracks the process variable value continuously while in manual. LSP=PV at the moment you switch from manual to automatic. LSP holds at this one value.
Manual or Auto Local to Automatic Remote SP	The Remote setpoint value with Ratio and Bias applied is used to calculate the control setpoint. Auto Bias is a configurable feature which modifies this. When it is selected, the transfer from automatic local to automatic remote or from manual remote to auto remote adjusts the Bias based on the local setpoint such that Bias = LSP - [IN2 x R].
Automatic Remote SP to Manual or Auto Local Setpoint	If configured for Local Setpoint Tracking, when the UDC transfers out of remote setpoint, the last value of the control setpoint is inserted into the local setpoint. If LSP tracking is not configured, the local setpoint will not be altered when the transfer is made.

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5.6 Operating Modes, Continued

Selecting Manual or Automatic mode

An alternate action switch places the controller in Automatic or Manual mode of operation.

Switching between manual and automatic will be bumpless, except when PD+MR algorithm is selected.

Table 5-9 includes procedures for selecting automatic or manual mode and changing the output while in manual.

Table 5-9 Procedure for Selecting Automatic or Manual Mode

Step	Operation	Press	Action
1	Selecting Automatic Mode	MAN AUTO	until "AUTO" indicator is ON. The controller regulates its output to maintain the PV at the desired setpoint. Upper Display — shows the PV value Lower Display — shows SP and the setpoint value The deviation bargraph indicates the PV deviation from the setpoint. The annunciators will indicate whichever setpoint is in use: SP Local Setpoint 2SP Second Local Setpoint RSP Remote Setpoint CSP Computer Setpoint
2	Selecting Manual Mode	MAN AUTO	until "MAN" indicator is ON. The controller holds its output at the last value used during automatic operation and stops adjusting the output for changes in setpoint or process variable. Upper Display — shows the PV value Lower Display — shows OUT and the output value in (%). The bargraph will indicate Deviation or Output whichever is configured.

Table 5-9 continued on next page

5.6 Operating Modes, Continued

Selecting Manual or Automatic mode, continued

Table 5-9 Procedure for Selecting Automatic or Manual Mode, continued

Step	Operation	Press	Action
3	Adjust the Output in Manual Mode	▲ or ▼	to adjust the output value while in manual mode. Upper Display — shows the PV value Lower Display — shows OUT and the output value in %.
4	Return to Automatic Mode	MAN AUTO	The "A" indicator will appear indicating Automatic mode.

5.7 Setpoints

Introduction

You can configure the following setpoints for the UDC5000 controller.

- A single local setpoint
- 2 local setpoints toggled by the [SP1/SP2] key.
- A third local setpoint toggled by the [REMSP] key.

Selecting the local setpoint source

Use the procedure in Table 5-10 to select a local setpoint source.

Table 5-10 Procedure for Selecting the Local Setpoint Source

Step	Operation	Press	Action
1	Enter Set Up mode	SET UP	until the displays read: Upper Display [SET UP] Lower Display [CONTROL] or Upper Display [SET UP] Lower Display [CONTROL2] for Loop 2
2	Display Local Setpoint Source selections	FUNC	until the displays read: Upper Display [ ] ← Setpoint source selections: 1 ONLY, TWO, THREE Lower Display [LSP'S]
3	Select the desired source	▲ or ▼	to select the desired setpoint source in the upper display.
4	Return to control	LOWR DISP	The controller will assume normal control.

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5.7 Setpoints, Continued

Changing local setpoint 1 or 2 or 3

Use the procedure in Table 5-11 to change either of the local setpoint value.

Table 5-11 Procedure for Changing the Local Setpoints

Step	Operation	Press	Action
1	Select the setpoint	LOWR DISP	until you see Upper Display — The PV value Lower Display — SP, 2SP, or 3SP and the local setpoint value
2	Change the value	▲ or ▼	to change the local setpoint to the value at which you want the process maintained. SP, 2SP, or 3SP indicator will light to match the lower display.

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5.7 Setpoints, Continued

Switching between local setpoint 1 and 2

Use the procedure in Table 5-12 to switch between Local Setpoint 1 and 2.

Table 5-12 Procedure for Switching Between Local Setpoint 1 and 2

Step	Operation	Press	Action
1	Select the setpoint	SP1 SP2	to alternately switch between local setpoint 1 and local setpoint 2 (when configured). You will see: Upper Display — The PV value Lower Display — SP and the local setpoint #1 value, or 2 SP and the local setpoint #2 value
2	Change the value	▲ or ▼	to change the local setpoint to the value at which you want the process maintained. The display "blinks" if you attempt to enter setpoint values beyond the high and low setpoint limits. SP, 2SP, or 3SP indicator will light to match the lower display. ATTENTION "KEY ERROR" will appear in the lower display if the 2nd local setpoint is not configured as a setpoint source or if you attempt to change the setpoint while a setpoint ramp is enabled. Setpoint ramp rate will apply to changes between local SP and local SP2, if enabled.

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Switching between local setpoint 3 and local setpoints 1 or 2.

Use the procedure in Table 5-13 to switch between Local Setpoint 3 and Local Setpoint 1 or 2.

Table 5-13 Procedure for Switching Between Local Setpoint 3 and Local Setpoint 1 or 2

Step	Operation	Press	Action
1	Select the setpoint	REM SP	to alternately switch between local setpoint 3 and local setpoint 1 or local setpoint 2 (when configured).
2	Change the value	▲ or ▼	to change the local setpoint to the value at which you want the process maintained. The display "blinks" if you attempt to enter setpoint values beyond the high and low setpoint limits. SP, 2SP, or 3SP Indicator will light to match the lower display. **ATTENTION** "KEY ERROR" will appear in the lower display if 3 local setpoints are not configured or remote setpoint is not configured. Setpoint Ramp Rate will apply, if enabled.

Continued on next page

Selecting the remote setpoint source

You can select what you want your remote setpoint to be for each loop:

- None
- Remote setpoint using input 2 toggled by the [REMSP] key
- Remote setpoint using input 3 toggled by the [REMSP] key

Use the procedure in Table 5-14 to select the remote setpoint source.

Table 5-14 Procedure for Selecting the Remote Setpoint Source

Step	Operation	Press	Action
1	Select Set Up Group	[SET UP]	Until you see: Upper Display [SET UP] Lower Display [CONTROL] or Upper Display [SET UP] Lower Display [CONTROL2] for Loop 2
2	Select the Remote Setpoint Source Prompt	[FUNC]	Until you see: Upper Display [ ] ← The Remote Setpoint source selection Lower Display [RSP SRC] NONE - not used IN 2 - Input 2 as RSP IN 3 - Input 3 as RSP
3	Change selection	▲ or ▼	to change the remote setpoint source. [ATTENTION] You cannot change the Remote Setpoint Value using these keys.
4	Return to normal operation	[LOWR DISP]	This will return the controller to normal operation.

Continued on next page

Switching between local and remote setpoints

You can switch between Local and Remote setpoints. Use the procedure in Table 5-15 to switch between setpoints.

Table 5-15 Procedure for Switching Between Local and Remote Setpoints

Step	Operation	Press	Action
1	Select Local setpoint	REM SP	Until you see: Upper Display The PV value Lower Display SP,or 2SP and the local setpoint value
2	Change the Local setpoint value	▲ or ▼	The REMOTE setpoint cannot be changed at the keyboard.
3	Select Remote setpoint	REM SP again	You will see: Upper Display The PV value Lower Display RSP and the remote setpoint value

Continued on next page

Setpoint selection indication

Table 5-16 shows what the displays show for each type of setpoint.

Table 5-16 Setpoint Selection Indication

	Using Local Setpoint	Using Remote Setpoint	Using 2nd Local Setpoint	Using 3rd Local Setpoint
Upper Display	PV	PV	PV	PV
Lower Display	SP and the Local Setpoint Source	RSP and Remote Setpoint Value	2SP and the 2nd Local Setpoint Value	3SP and the 3rd Local Setpoint Value

5.8 Alarm Setpoints

Introduction

An alarm consists of a relay contact and an operator interface indication. When an alarm is in effect, the alarm relay may or may not be energized depending on the configuration of the alarm relay coil in the Alarm Configuration Set Up group, Function prompt "ALM ACTN".

The relay contacts can be configured for normally open (NO)-*energized* or normally closed (NC) *de-energized* by jumper selection. See *Section 2 - Installation* for alarm relay contact information.

There are four alarm setpoints, two for each alarm.

The type and state (High or Low) is selected during configuration. See *Section 3 - Configuration* for details.

Procedure for displaying the alarm setpoints

The procedure for displaying and changing the alarm setpoints is listed in Table 5-17.

Table 5-17 Procedure for Displaying or Changing the Alarm Setpoints

Step	Operation	Press	Action
1	Access the Alarm Setpoint Values	ALM 1 or ALM 2	to successively display the alarm setpoints and their values. Their order of appearance is shown below. Upper Display — The alarm setpoint value Lower Display — For [ALM 1] Key A1S1 VAL = (Alarm 1, Setpoint 1 value) A1S2 VAL = (Alarm 1, Setpoint 2 value) For [ALM 2] Key A2S1 VAL = (Alarm 2, Setpoint 1 value) A2S2 VAL = (Alarm 2, Setpoint 2 value)
		▲ or ▼	to change any alarm setpoint value you select in the upper display.
2	Access the Alarm Type or State	ALM 1 or ALM 2	Until you see one of the following prompts in the lower display. **For [ALM 1] key** A1S1 TYPE = (Alarm 1, Setpoint 1 type) A1S2 TYPE = (Alarm 1, Setpoint 2 type) A1S1 H L = (Alarm 1, Setpoint 1 state) A1S2 H L = (Alarm 1, Setpoint 2 state) **For [ALM 2] Key** A2S1 VAL = (Alarm 2, Setpoint 1 value) A2S2 VAL = (Alarm 2, Setpoint 2 value) A1S1 H L = (Alarm 1, Setpoint 1 state) A1S2 H L = (Alarm 1, Setpoint 2 state) Use ▲ or ▼ to change selection.
3	Return to normal operation	LOWR DISP	

5.9 Single Setpoint Ramp

Configuring the setpoint ramp

You can configure a single setpoint ramp to occur between the current local setpoint and a final local setpoint over a time interval of from 1 to 255 minutes. You can RUN or HOLD the ramp at any time.

Procedure

Table 5-18 lists the procedure for configuring the Setpoint Ramp parameters. For SP Program, see Section 6.

Table 5-18 Procedure for Configuring a Setpoint Ramp

Step	Operation	Press	Action
1	Select SP RAMP Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display SP RAMP
2	Select the Setpoint Ramp function	FUNC	Until you see: Upper Display Enable —SP Ramp for Loop 1 Enable 2 —SP Ramp for Loop 2 Enable 12 —SP Ramp for Loops 1 and 2 Lower Display SP RAMP
3	Enable Setpoint Ramp	▲	to enable the setpoint ramp function. Choose the Loop(s) on which you want the ramp to operate. NOTE: You cannot change the current local setpoint if the setpoint ramp function is enabled
4	Set the Ramp Time	FUNC	Until you see: Upper Display — The ramp time in minutes Lower Display TIME MIN
		▲ or ▼	to change the upper display value to the number of minutes in which you want the final setpoint to be reached. Setting Range = 0 to 255 minutes NOTE: Entering "0" will imply an immediate step change to the final SP.
5	Set the Final Setpoint value	FUNC	Upper Display — The Final Setpoint value Lower Display FINAL SP
6		▲ or ▼	to change the upper display value to the desired final setpoint value. Setting Range = within the setpoint limits

5.9 Single Setpoint Ramp, Continued

Running the setpoint ramp

Running a Setpoint Ramp includes starting, holding, viewing the ramp time, ending the ramp and disabling it.

Procedure

Table 5-19 lists the procedure for running the Setpoint Ramp.

Table 5-19 Procedure for Running a Setpoint Ramp

Step	Operation	Press	Action
1	Put the controller into Automatic mode	MAN AUTO	until "AUTO" indicator is ON and you will see: Upper Display — H and the PV value Lower Display — SP and the present setpoint value
2	Set Start SP	▲ or ▼	until the start setpoint value you desire is indicated in the lower display: Upper Display — H and the PV value Lower Display — SP and the start setpoint value
3	Start the Ramp	RUN HOLD	you will see: Upper Display — R and the PV value Lower Display — SP and a changing setpoint value NOTE: The value in the lower display will be increasing or decreasing toward the final setpoint value. The PV value in the upper display will also change.
4	Hold/Run the Ramp	RUN HOLD	To hold the ramp at the current setpoint value. Press again to continue run. A "KEY ERROR" prompt will appear if RUN/HOLD key is pressed while "SP RAMP" is disabled.
5	View the remaining ramp time	LOWR DISP	Until you see: Upper Display — R or H and the PV value Lower Display — RAMP XXXM (Time remaining)

Table 5-19 continued on next page

Procedure, continued

Table 5-19 Procedure for Running a Setpoint Ramp, continued

Step	Operation	Press	Action
6	Change setpoint during HOLD mode	▲ or ▼	to change the "HELD" setpoint if the ramp is on "HOLD". However, the ramp time remaining is not changed. Therefore, when returning to RUN mode, the setpoint will ramp at the same rate as previous to Local setpoint changes and will stop if the Final setpoint is reached before time expires. If the time expires before the final setpoint is reached, it will jump to the final setpoint.
6	End the Ramp		When the final setpoint is reached, the "R" changes to "H" in the upper display and the controller operates at the new setpoint. ATTENTION Anytime the local setpoint is different from the final setpoint value and the RUN/HOLD key is pressed - the ramp will start again.
7	Disable the setpoint ramp function	SET UP	Until you see: Upper Display SET UP Lower Display SP RAMP
		FUNC	You will see: Upper Display Enable – SP Ramp for Loop 1 Enable 2 – SP Ramp for Loop 2 Enable 12 – SP Ramp for Loops 1 and 2 Lower Display SP RAMP
		▲	Until you see: Upper Display DISABL Lower Display SP RAMP
8	Return to normal operating mode	LOWR DISP	

5.10 Using Two Set of Tuning Constants

Introduction

You can use two set of tuning constants for single output types and 2 Loop or Cascade control and choose the way they are to be switched. (Does not apply for Duplex Control).

The sets can be:

- Keyboard selected
- Automatically switched when a predetermined Process Variable value is reached.
- Automatically switched when a predetermined Setpoint value is reached.

The following procedures show you how to:

- Select two sets
- Set the switch-over value
- Set tuning constant value for each set
- Switch between two sets via the keyboard (without automatic switch-over)

Select two sets

The procedure in Table 5-20 tells you how to select two sets of tuning constants.

Table 5-20 Procedure for Selecting Two Set of Tuning Constants

Step	Operation	Press	Action
1	Select Control Set Up group	SET UP	Until you see: Upper Display: SET UP Lower Display: CONTROL or For Loop 2 Upper Display: SET UP Lower Display: CONTROL 2
2	Select PID SETS function	FUNC	Until you see: Upper Display: (Available selections are listed below) Lower Display: PID SETS 1 ONLY - 1 set of constants 2 KEYBD - 2 sets, keyboard selectable 2 PVSW - 2 sets, auto switch at PV value 2 SPSW - 2 sets, auto switch at SP value
		▲ or ▼	to select the type of PID SET in the upper display.

Continued on next page

5.10 Using Two Set of Tuning Constants, Continued

Set switch-over value

If you select 2 PVSW or 2 SPSW, you must set a value at which the sets will switch over.
The procedure in Table 5-21 shows you how to set this value.

Table 5-21 Procedure for Setting Switchover Values

Step	Operation	Press	Action
1	Select Switchover value function	FUNC assuming you are still in Set Up group "CONTROL"	Until you see: Upper Display: [ ] ← The switchover value Lower Display: SW VALUE
		▲ or ▼	to select the switch-over value in the upper display.

Set Tuning constant values for each set

There are specific tuning constants that must be set for each set. The procedure in Table 5-22 shows you how to access these constants and change their values.

Table 5-22 Procedure for Setting Tuning Constant Values

Step	Operation	Press	Action
1	Select Tuning Set Up Group	SET UP	Until you see: Upper Display: SET UP Lower Display: TUNING
2	Select the tuning constants	FUNC	to successively display the following constants: Upper Display: [ ] ← The tuning constant value Lower Display: [ ] ← For Primary Loop PROP BD or GAIN* RATE* RSET* PROP BD2 or GAIN2** RATE 2** RSET2** For Loop 2 PROP BD3 or GAIN3* RATE3* RSET3* PROP BD4 or GAIN4** RATE 4** RSET4**
		▲ or ▼	To change the value of any of the above listed prompts in the lower display.

*PIDSET1 – will be used when PV or SP whichever is selected, is greater than the switchover value.
**PIDSET2 – will be used when PV or SP, whichever is selected, is less than the switchover value.

Continued on next page

5.10 Using Two Set of Tuning Constants, Continued

Switch between two sets via the keyboard (without automatic switch-over)

This procedure is operational only if 2 PID SETS was configured at "CONTROL" set up group.

The procedure in Table 5-23 shows you how to switch from one set to another.

Table 5-23 Procedure for switching PID SETS from the Keyboard

Step	Operation	Press	Action
1	Access the PID set display	LOWR DISP	Until you see: Upper Display [ ] ← The PV value Lower Display PIdSETX X= 1 or 2
		▲ or ▼	to change PID SET 1 to PID SET 2 or vice versa. You can Autotune both sets on either loop. See Subsection 5.17

5.11 2 Loops of Control Overview

Introduction

The UDC5000 can operate using Two Independent Loops of control or Internal Cascade control.

TWO INDEPENDENT LOOPS - See Functional Overview Block Diagrams for Loop 1(Figure 5-1) and Loop 2 (Figure 5-2) and Table 5-24 for selections based on these diagrams.

The following rules apply for Two independent loops:

- Current Output on Loop 2 requires Auxiliary output.
- Loop 2 Relay Output is always dedicated to relay 2.
- Loop 2 Current Duplex output is limited to Auxiliary output signal only.
- No Position Proportional or Relay Duplex Outputs on Loop 2.
- No ON/OFF or 3 Position Step algorithm in Loop 2.

INTERNAL CASCADE CONTROL - uses Loop 2 as the primary loop with the output of loop 2 being the remote setpoint of Loop 1.
See Functional Overview Block Diagrams (Figure 5-3) and Table 5-24 for selections based on these diagrams.

The following rules apply for Internal Cascade control:

- Loop 2 must be the primary loop
- Loop 1 must be the secondary (internal or slave) loop because all output forms exist on Loop 1
- Loop 1 remote setpoint is fixed as Loop 2 output.

Selections

Refer to Figures 5-1, 5-2, and 5-3 Block Diagrams and Table 5-24 for selections based on these diagrams.

Table 5-24 Selections

LOOP		INPUT 1	INPUT 2	INPUT 3	INPUT 2 ALGORITHM	INPUT 3 ALGORITHM
LOOP 1	Process Variable	Yes	Remote Switching between Inputs 1 and 2	Remote Switching between Inputs 1 and 3	HI/LO Select Summing Carbon Poten Rel Humidity Mult/Div with Input 1	HI/LO Select or Summing with Input 1
	Remote Setpoint	No	Yes	Yes	No	No
	Feedforward	No	See Input 2 Algorithm	See Input 3 Algorithm	Feed forward 1	Feed forward 1
LOOP 2	Process Variable	Yes via configuration	Via Configuration or Remote Switch 2	Via Configuration or Remote Switch 2	No	No
	Remote Setpoint	No	Yes	Yes	No	No
	Feedforward	No	See Input 2 Algorithm	See Input 3 Algorithm	Feed forward 2	Feed forward 2

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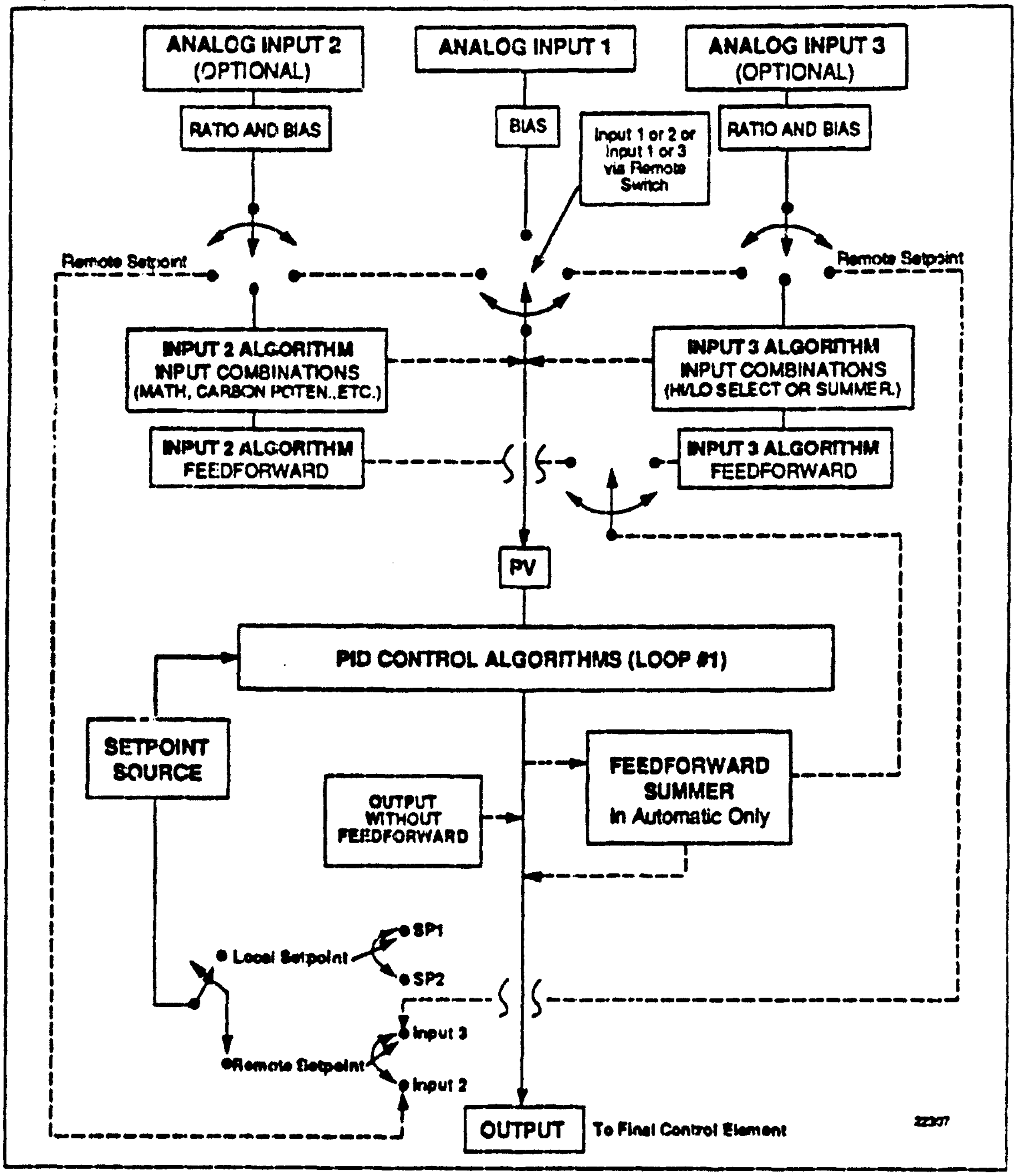
Single Loop Controller Figure 5-2 is is a Block Diagram of a Single Loop Controller - Loop #1.

Figure 5-2 Functional Overview Block Diagram of a Single Locp Controller - Loop #1



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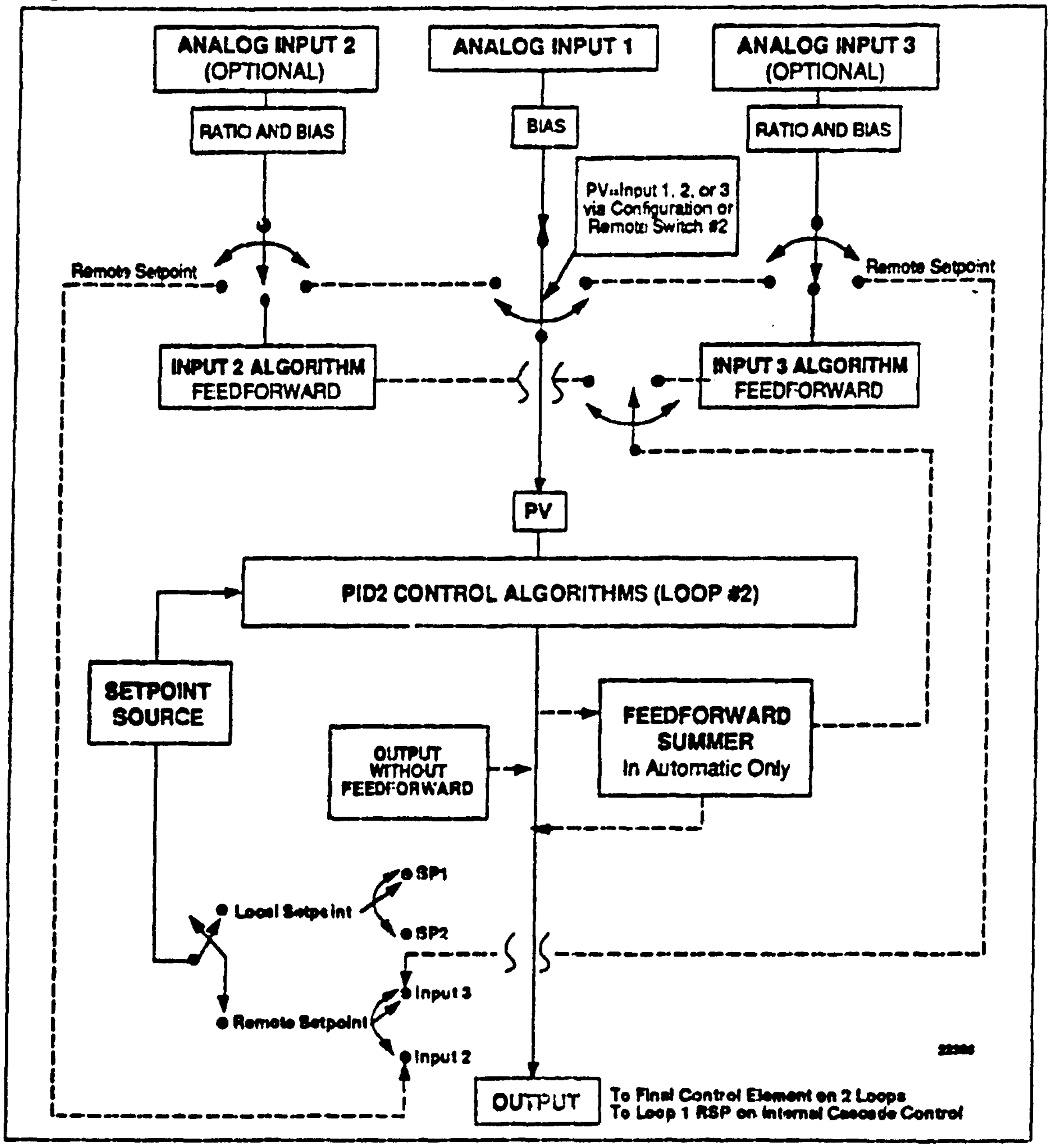
Loop 2 Figure 5-3 is is a Block Diagram of a Loop 2 of a 2 Loop controller..

Figure 5-3 Functional Overview Block Diagram of Loop 2 of a 2 Loop Controller



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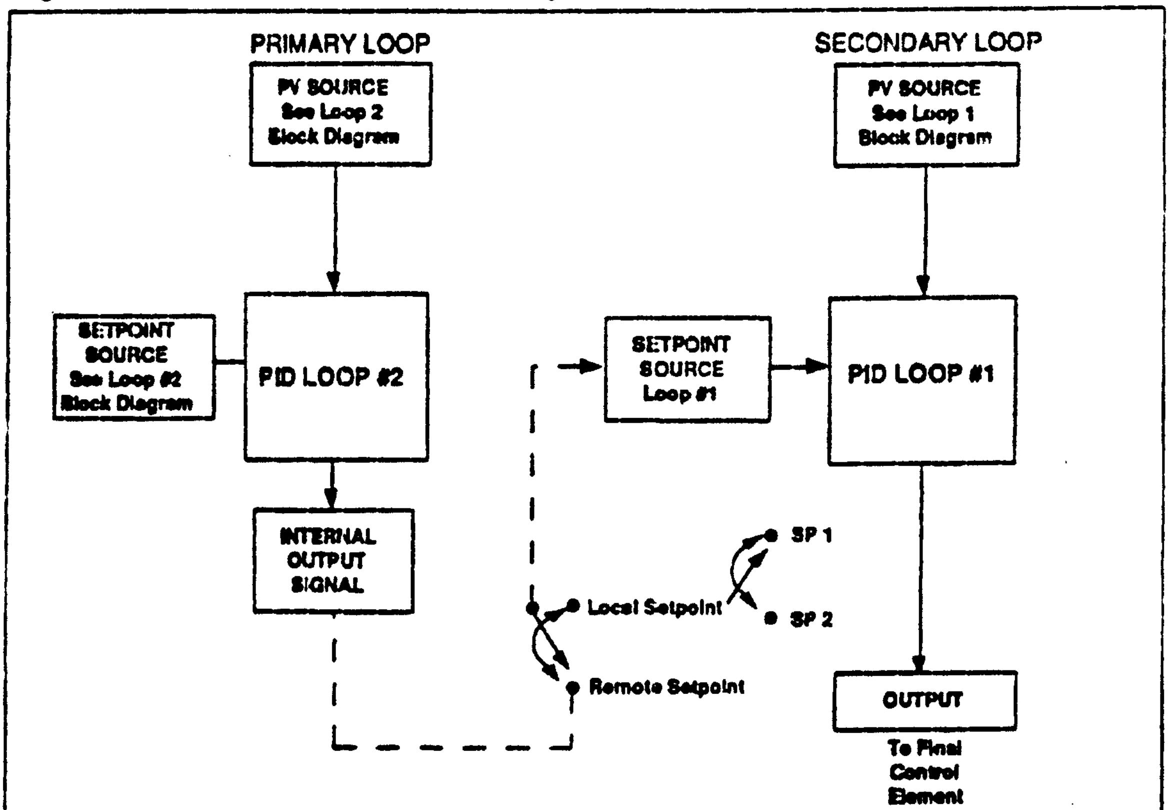
Internal Cascade

Figure 5-4 is is a Block Diagram of Internal Cascade for a 2 Loop controller.

Figure 5-4 Functional Overview Block Diagram of Internal Cascade of a 2 Loop Controller



INTERNAL CASCADE RULES

- Loop #2 must be the primary loop.
- Loop #1 must be the secondary (internal or slave) loop because all output forms exist on Loop 1.
- Loop #1 Remote Setpoint is fixed as loop #2 output.

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Override rules

The UDC5000 allows you to select high or low output override. Refer to *Section 3 - Configuration* to select High or Low.

The following rules apply for high/low override:

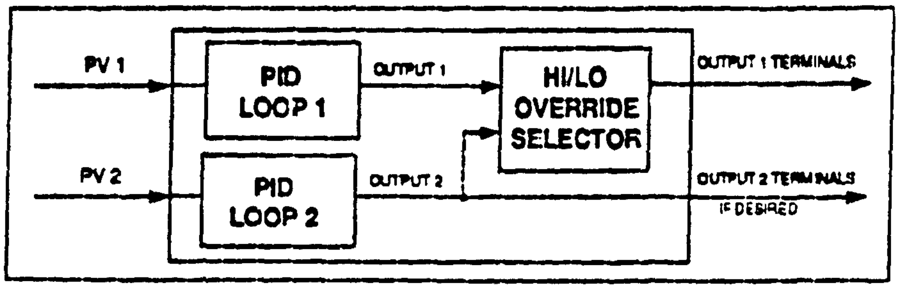
• Only one physical output is required when override is enabled. It is the output from Loop 1 because Loop 2's internal output is routed through the selector.

• Loop 2 output can also be available at all times if desired.

• The unselected output will never change by more than 5% from the selected output (No Windup).

Figure 5-5 is a block diagram of the HI/LO Override Selector.

Figure 5-5 Hi/Lo Override Selector



5.12 Configure 2 Loop of Control

Select 2 loop algorithm

The procedure in Table 5-25 shows you how select the 2 loop algorithm.

Table 5-25 Procedure for Selecting 2 Loop Algorithm

Step	Operation	Press	Action
1	Select Algorithm Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display ALGORTHM
2	Select the PID Loops	FUNC	to successively display the following constants: Upper Display (1 LOOP, 2LOOPS, CASCADE) Lower Display ALGORTHM
		▲ or ▼	To select 2 Loops or Cascade.

Select the output algorithm for each loop

See *Subsection 5.11* for rules and regulations then follow the procedure in Table 5-26.

Table 5-26 Procedure for Selecting Output Algorithm for each Loop

Step	Operation	Press	Action
1	Select Output Algorithm Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display OUT ALG
2	Select Loop 1 Algorithms	FUNC	to successively display the following constants: Upper Display (TIME, CURRNT, POSITN, TIME D, CUR D, CUR TI, TI CUR) Lower Display OUT ALG
		▲ or ▼	To select Loop 1 algorithm.

Table 5-5 continued on next page

Select the output algorithm for each loop, continued

Table 5-26 Procedure for Selecting Output Algorithm, continued

Step	Operation	Press	Action
3	Select Loop 2 algorithms	FUNC	Until you see: Upper Display [ ] ← NONE, TIME, CURRNT, CUR D, CUR TI, TI CUR; Lower Display OUT 2 ALG
		▲ or ▼	To select Loop 2 algorithm.

Select control parameters for each loop

The procedure in Table 5-27 shows you how select the 2 loop algorithm.

Table 5-27 Procedure for Selecting Control Parameters

Step	Operation	Press	Action
1	Select Control Set Up Group	SET UP	Until you see: Upper Display SET UP, Lower Display CONTROL or Upper Display SET UP, Lower Display CONTROL2 For Loop 2
2			Refer to *Subsection 5.11* for rules and restrictions and to *Section 3 - Configuration* to select the individual parameters.

Continued on next page

Select tuning parameters for each group

The procedure in Table 5-28 shows you how select the Tuning Parameters.

Table 5-28 Procedure for Selecting Tuning Parameters

Step	Operation	Press	Action
1	Select Tuning Set Up Group	SET UP	Until you see: Upper Display: SET UP / Lower Display: TUNING or Upper Display: SET UP / Lower Display: TUNING 2 For Loop 2 PID set 1 and 2 (TUNING) are for Loop 1 and single loop applications. PID set 3 and 4 (TUNING2) are for Loop 2 in two loop and cascade control applications.
2	Select Tuning constants	FUNC	to successively display the following constants: Upper Display ← The Tuning Constant Value Lower Display ← TUNING CONSTANTS for Primary Loop PROP BAND or GAIN RATE (MIN) RESET (MIN OR RPM) CYCLE PROP BAND2 or GAIN2 RATE2 (MIN) RESET2 (MIN OR RPM) CYCLE2 OR TUNING CONSTANTS for LOOP 2 PROP BAND3 or GAIN3 RATE3 (MIN) RESET3 (MIN OR RPM) CYCLE3 PROP BAND4 or GAIN4 RATE4 (MIN) RESET4 (MIN OR RPM) CYCLE4 Refer to *Section 3 - Configuration* for detailed information. You can Autotune both sets on either loop. Refer to *Subsection 5.17*. Use the FUNC key to switch between loops.
		▲ or ▼	To change the values.

5.13 Monitor 2 Loops of Control

Introduction

Monitoring two individual loops of control or Internal Cascade is the same as a single loop except that OUT Indicator 1 and 2 become Loop 1 and Loop 2 indicators when more than one control loop is enabled.

Loop display

Display of Loop 1 or Loop 2 (if configured) is done by toggling the [FUNC] key.

Viewing each loop's process variable

Regardless of which loop is being displayed "1" or "2", the process variable of the non-displayed loop can be shown in the lower display by repeated presses of the [LOWR DISP] key until "1PVXXXX" or "2PVXXXX" is displayed.

Internal cascade indication

When Internal Cascade has been configured, an "I" will appear on the left side of the upper display as long as Loop 1 is operating in the remote setpoint mode (for example: RSP is displayed)

If Local setpoint 1 and 2 is being used, the "I" will disappear until the remote setpoint [REM SP] key is pushed to switch from local setpoint to remote setpoint.

Switching between automatic and manual modes on either loop will not affect the Internal Cascade indication.

5.14 Operate 2 Loops of Control

Loop operation	Operation of two individual loops of control is identical to operating a single loop of control except that TUNING 2 group applies to Loop 2 only and two PID sets, 3 and 4, are available. TUNING group applies to Loop 1 with PID sets 1 and 2 applicable.
Operating modes and setpoint source	The rules for Auto/Manual modes and changing setpoint sources are the same as single loop operation.
Keyboard operation	Note that the loop being displayed is the only loop affected by normal keyboard operation. However, either loop can be reconfigured when in the Set Up mode regardless of which is being displayed during normal operation.
Autotune	Each loop can be Autotuned, but they must be tuned separately (one at a time). Configure the loop to be enabled and the type of Autotune (automatic or manual step) then follow the normal rules for Autotune.
Adaptive tune	Two independent loops or cascaded loops can be Adaptive tuned at the same time, if configured.
Setpoint Ramp or Setpoint programming	Either loop or both loops can be configured for a single setpoint ramp operation or setpoint programming by enabling the desired loop or loops (see *Section 3 - Configuration*). An "H" or "R" will appear when applicable, depending upon which loop is being displayed. The RUN/HOLD operation is shown in Table 5-19 "Running a Single Setpoint Ramp".
Digital inputs (remote mode switching)	Digital Input Switch 2 is dedicated to Loop 2 and Digital Input Switch 1 is dedicated to Loop 1 when two loops or Cascade control is configured.
Output override Hi/Lo select	Output Override allows you to select the higher of Output 1 and Output 2 (Hi Select) or the lower of Output 1 and Output 2 (Lo Select) to appear at Output 1 terminals to drive the final control element. Refer to *Subsection 5.11* or Override rules and block diagram. Override prompts appear under Set Up group "ALGORTHM" and function prompt "OUT OVRD".
Internal Cascade control	Internal cascade is a function of 2 Loops of control where Loop 2 is the primary loop and the output of Loop 2 is the remote setpoint of Loop1. Refer to Figure 5-4 block diagram.

5.15 Digital Input Option (Remote Switching)

Introduction

The Digital Input option detects the state of external contacts for either of two inputs. On contact closure, the controller will respond according to how each switching input is configured.
If the controller is configured for either Two Loop or Cascade control, then switch #1 operates only on Loop 1 and switch #2 operates only on Loop 2. Make your selection under Set Up group "OPTION", function group prompt "REM SW1" or "REM SW2". See *Section 3 - Configuration*.

Action on closure

Table 5-29 lists the configuration prompt selections, the "Action on Closure", and the display indication for each selection available.

ATTENTION This feature acts as a toggle. If closing contact causes action noted in Table 5-29; reopening contact causes a switch back to the original state or mode.

Table 5-29 Digital Input Option Action on Contact Closure

REMSW1 or REM SW2 selections	Display Indication	Action on contact closure*
To MAN	"MAN" blinks	Puts the controller into manual mode
To SP1	"SP" blinks	Switches out of remote setpoint and selects the local setpoint.
To SP2	"2 SP" blinks	Switches out of first local setpoint and selects the second local setpoint.
To DIR	None	Selects direct controller action.
ToHOLD	"H" blinks	Suspends setpoint ramp or setpoint program.
ToPID2	PID SET2 in lower display	Selects PID2 (transfer if using PID SET 1)
PV IN2	"II IN" blinking	Selects the PV to equal Input 2. (not available for 2Loop, Cascade control, or Carbon Potential Output)
PV IN3	"III IN" blinking	Selects the PV to equal Input 3
To RUN	"R" indicator blinks	Starts a stopped SP Ramp or SP Program.
To BEGN	"R" blinks if in RUN "H" blinks if in HOLD	Resets the SP Program to the setpoint at the beginning of the program without any change in mode or program status.

Keyboard operation

If a particular mode or parameter is selected by the contact closure, using the keyboard to select the same parameter will ensure that the selected mode will be maintained after the remote digital switch is re-opened. The display will blink when the key is pressed; no other indication is made.

5.16 Adaptive Tune(Accutune™)

Introduction

Adaptive Tune will continually adjust the Gain or Proportional Band (P), Rate (I), and Reset Time (D) tuning constants in response to setpoint changes and/or Process Variable disturbances.

Adaptive Tune handles all Local, Remote, and Computer Setpoint changes.

How it works

Adaptive Tune uses a combination of frequency response analysis, time domain analysis, and the rule based expert system techniques to identify the two most dominant process lags plus any dead time.

It then automatically readjusts the PID parameters as necessary. It does this while controlling to setpoint in automatic (closed loop) control mode.

These calculated PID values can be changed, if desired, by disabling Adaptive Tune and entering different values.

Tuning can be aborted by pushing [Man/Auto] key to return to manual mode.

Setpoint changes

During start-up, or whenever the setpoint changes, Adaptive Tune employs time domain analysis to tune the process at any desired setpoint without any prior initialization or process knowledge.

Process variable disturbances

During Process Variable (PV) disturbances which result from non-linearities, process dynamics, load changes or other operating conditions. Adaptive Tune uses frequency response analysis techniques to continually respond to PV disturbances as small as 0.3%.

Rules and regulations

The following is a list of rules and regulations for Adaptive Tune. Adaptive Tune:

- can tune on all Local, Remote or Computer setpoints
- will work only for algorithms PID-A or PID-B selections
- is done in automatic mode
- can operate during setpoint ramp or setpoint programming
- can be monitored or reconfigured over Honeywell's communication network
- can be disabled via Remote Switching Inputs
- can tune two independent loops or cascaded loops at the same time
- does not bump the output during operation
- cannot be used with 3 position step
- When a setpoint Adaptive Tune is in progress, a large "T" appears in the upper display. During this time, no changes to the configuration parameters, including the setpoint, are permitted.

Continued on next page

5.16 Adaptive Tune (Accutune™), Continued

Configuration

Before starting Adaptive Tune you must

- enable the Adaptive Tune feature
- select whether you want to adaptive tune on setpoint changes only or both setpoint and PV changes.
- set the minimum value of setpoint change in % of span that will result in re-tuning.

Procedure

Use the procedure in Table 5-30 to configure these items.

Table 5-30 Procedure for Configuring Adaptive Tune Parameters

Step	Operation	Press	Action
1	Select Autotune Set Up Group	SET UP	Until you see: Upper Display: SET UP Lower Display: AUTOTUNE
2	Select Adaptive Tune	FUNC	you will see either: Upper Display: ADAPT - Adaptive Tuning or A TUNE - Autotune Lower Display: TUNETYPE
		▲ or ▼	until ADAPT appears in the upper display.
3	Select the type of Adaptive Tune for Loop 1	FUNC	You will see: Upper Display: DISABLE, SP ONLY SP + PV Lower Display: ADAPTUNE DISABLE - Adaptive Tune disabled SP ONLY - Adaptive Tune will occur on setpoint changes only SP + PV - Adaptive Tune will occur on Setpoint changes and also when there is a Process Variable disturbance of greater than 0.3% of span.
		▲ or ▼	until the desired selection appears in the upper display.

Table 5-30 continued on next page

Configuration, continued

Table 5-30 Procedure for Configuring Adaptive Tune Parameters, continued

Step	Operation	Press	Action
4	Enter the setpoint change value for Loop 1	FUNC	until you see Upper Display [←] Range: ±5 to 15% of PV Span Lower Display SP CHANG This is the minimum setpoint change value on which re-tuning will occur. Example: If the range is 0 to 2000, and 5% is configured here, re-tuning will occur if the setpoint change is 100 or larger.
		▲ or ▼	until the desired range appears in the upper display.
5	Verify or change the process Gain value for Loop 1	FUNC	You will see: Upper Display [←] Range: 0.01 to 50.00 Lower Display K P G The Process Gain Value is normally a READ only value. It should only be changed if the controller fails to identify the process. In this case, set the value to the algebraic value of PV in percent, divided by output in percent, as displayed while in manual mode.
		▲ or ▼	until the desired range appears in the upper display.
If Loop 2 is configured: The procedure is the same as listed for Loop 1 except the prompts will be: ADAPT 2 SPCHANGE2 K P G 2			

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Start-up mode

At start-up, SP ADAPT tuning is used. The procedure for start-up is listed in Table 5-31.

Table 5-31 Procedure for Using Adaptive Tune at Start-up

Step	Operation	Press	Action
1	Put the controller into manual mode	MAN AUTO	Until the MAN indicator is ON. You will see: Upper Display [ ] ← the PV value Lower Display OUT XXX.X
		▲ or ▼	to adjust the output value in the lower display, so that the PV lines out at least 10% of PV range and much lower than the normal setpoint setting.
2	Let PV stabilize		Allow the PV to stabilize (stop changing). Depending on the response time of the process, you may have to wait a while for the PV value to line out. Watch the displays for a stable condition.
3	Adjust the setpoint	LOWR DISP	Until you see: Upper Display [ ] ← the PV value Lower Display SP XXXX
		▲ or ▼	to adjust the setpoint value in the lower display to the desired setpoint at which you plan to operate after Adaptive Tune is completed.
4	Start SP ADAPT tuning	AUTO TUNE	The controller will switch to automatic mode and the process will start to move toward the setpoint and will line out with the proper tuning constants. A large "T" appears on the left side of the upper display to indicate that (SP ADAPT) Adaptive tune is in progress. You will see: Upper Display T XXXX ← the PV value Lower Display SP XXXX ← the setpoint value If you switch to automatic [MAN/AUTO key] instead of pressing the [AUTOTUNE] key, "PV ADAPT" will occur (if the PV is different than the setpoint) but it will take longer than SP ADAPT especially if the process is slow.

Table 5-31 continued on next page

SP ADAPT (after Start-up)

SP ADAPT will occur whenever the controller is in automatic mode and a setpoint change occurs which is greater than the previously configured minimum setpoint change value.

The controller will delay using any setpoint changes for 30 seconds to enable it to calculate whether to "SP ADAPT" or not. But, if the controller is toggled between LSP1 and LSP2 or if any other key (such as LOWR/DISP) is pressed, the setpoint change is immediate.

A large "T" is displayed in the upper display whenever SP ADAPT mode is in progress. During this time, no changes to the configuration parameters, including the setpoint, are permitted.

PV Adapt

PV ADAPT will occur whenever a PV disturbance of 0.3% span or larger occurs. It will take 1 and 1/2 process cycles around the setpoint before any process recognition can occur.

A small "T" is displayed in the upper display whenever PV ADAPT mode is in progress. During this time, changes to the configuration parameters are permitted. However, this may cause the PV adapt process to abort.

Aborting Adaptive Tuning

If it is necessary to stop or abort the tuning, press the [Man/Auto] key to return to Manual mode. This will cause an immediate abort of tuning.

Also, Adaptive Tune can be temporarily disabled by properly configuring a digital input.

Continued on next page

Re-Tuning

The controller will evaluate current tuning as SP and PV changes occur. When re-tuning is required, the controller operates in automatic mode controlling to new "intermediate" tuning constants until PV lines out within approximately 0.2% span of SP.

At that point, the "T" disappears and "Final" tuning values are entered and used until re-tuning occurs again. The controller never goes into manual and does not bump the output to evaluate tuning requirements.

Note that if re-tuning was not required, no changes will be made; but, the "T" will still occur to indicate that Adaptive Tune algorithm is measuring the process response.

Error code accessing procedure

When an error is detected in the Adaptive tune process, the message "AT ABORT" will appear in the lower display.

Access function prompt "AT ERROR" to determine what is causing the error. This procedure is listed in Table 5-32.

Table 5-32 Procedure for Accessing Adaptive Tune Error Codes

Step	Operation	Press	Action
1	Select Adaptive Tune Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display ADAPTIVE
2	Go to Error Code prompt	FUNC	You will see: Upper Display An error code Lower Display AT ERROR Table 5-33 lists all the Adaptive tune error codes and their definitions and what action to take to correct the error.

Continued on next page

Error codes

Table 5-33 lists the Adaptive Tune error codes and their definitions.

Table 5-33 Adaptive Tune Error Code Definitions

Upper Display Prompt	Code Definition	Action to Take
NONE	NO ERRORS	None
OUTLIMIT	SP Adapt step is greater than high output limit or less than low output limit	• Check the output limits under Set Up group prompt "CONTROL", function prompts "OUTHILIM" and "OUTLOLIM" in *Section 3 - Configuration*. • Check "PROCESS GAIN" (KPG). Refer to Table 5-30.
IDFAIL	Process Identification Failure	Try to SP Adapt again.
ABORT	• Manual abort has occured – Adaptive tune will abort if the MAN/AUTO key is pressed during tuning • Automatic Abort has occured – Adaptive tune will automatically abort when a pV oscillation has been detected during "SP ADAPT", whenever any SP values are changed during a "PV ADAPT", or when Adaptive Tune is disabled.	Try to SP Adapt again.
LOW PV	Occurs during a SP ADAPT when the output step calculated is too low to produce a PV value close to the desired setpoint.	NONE - After a period of about 5 minutes, the "SPADAPT" will be retried automatically with a larger output step.

5.17 Autotune

Introduction

Autotune automatically calculates Gain (PB), Rate (Derivative), and Reset (Integral) Time tuning constants on demand. These tuning constants are calculated at the end of the Autotune procedure based on the output step introduced onto the process.

How it works

An output step causing an approximately 4.0% change in PV will be automatically generated when Autotune is performed using the Auto step approach. If you select the manual step approach, you must select a specific output step size in % that will be large enough to result in at least a 2.5% PV change. These constants, once calculated, are automatically entered into the controller memory in their normal locations.

Slow or fast response

Autotune provides the theoretical PID constants which results in little or no overshoot. This usually provides a conservative Gain value which results in a slower response to insure no overshoot. If faster response is desired and some overshoot can be tolerated, the calculated Gain value can be increased by a factor of 2 or perhaps more or PB decreased by a factor of 2. Of course, the process loop must be checked for stability in the automatic mode.

Autotune Alarm

Alarm 1 is available to protect the process during Autotune. If alarm set point is exceeded during the sampling period Autotune will abort. This eliminates the need to continually monitor the Autotune sequence.

Where to operate Autotune

Autotune is most effective when implemented in the region of PV where you plan to operate. Don't Autotune at 900°F if you plan to operate at 1300°F. The process dynamics may be different at different energy levels. Always try to start Autotune 2.5% below your operating setpoint.

Short Tune feature

There is a SHORT TUNE feature that lets you obtain approximate tuning constants by prematurely implementing the Autotune calculation before the PV has fully lined out during the Autotune process.

Summary

In summary, Autotune and Short Tune can be used as a flexible tool to quickly identify Gain, Rate, and Reset time constants. Further tuning can be done using these values as a starting point.

IMPORTANT: Autotune will function only when the controller is in a closed loop system. Attempts to Autotune open loop will result in "ABORT" error message.

Continued on next page

Summary, continued

ATTENTION

• Set Point Ramp and Set Point Programming cannot be enabled while Autotune is in operation.
• Autotune can be applied to 3 Position Step Control.
• A STEP may be performed in automatic mode.
• M STEP must be in manual mode.

FOR 2 LOOP INTERNAL CASCADE

• On a 2 loop controller, each loop must be separately autotuned. Initiate the procedure for each loop.
• On Internal Cascade, first tune the second loop of control (Loop 1).

Configuration

Before starting Autotune you must

- enable the Autotune feature, make sure the AUTOTUNE key is not locked out.
- select whether you want the controller to generate an output step automatically (ASTP) or whether you want to enter an output step size manually (MSTP).
- set Alarm 1 Set Point 1 to proper type and value to protect process if desired – otherwise set to NONE to avoid accidental abort.
- select the set point at which you want it to line-out after Autotune.

Procedure

Use the procedure in Table 5-34 to configure the Autotune parameters.

Table 5-34 Procedure for Configuring Autotune Parameters

Step	Operation	Press	Action
1	Select Autotune Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display AUTOTUNE
2	Select Tune Type	FUNC	You will see: Upper Display ← ADAPT - Adaptive Tuning or A TUNE - Autotune Lower Display TUNETYPE
		▲ or ▼	until A TUNE appears in the upper display.

Table 5-34 is continued on next page

Procedure, Continued

Table 5-34 Procedure for Configuring Autotune Parameters, Continued

Step	Operation	Press	Action
3	Select output step type	FUNC	You will see: Upper Display: dIS Lower Display: AT EnAb
		▲ or ▼	to select "ASTEP or MSTEP" in the upper display Upper Display: (blank box, arrow pointing to the list below) Lower Display: AT ENABL **DISABL** **ASTEP**- (will generate the output step automatically) **MSTEP**- (requires you to manually enter a step size value under prompt "OUTSTP.") **ASTEP2**- (same as A STEP except cascade primary [loop2] or second control loop) **MSTEP2**- (same as MSTEP except cascade primary [loop2] or second control loop) If you select MSTEP go to step 4 If you select ATSTEP go to step 5.
4	Select Output Step Size for MSTEP	FUNC	You will see: Upper Display: (blank box, arrow pointing to the note) The value of the controller output step size in % Lower Display: OUTSTP Range of setting: -100 to 100% of output
		▲ or ▼	to choose an output step in percent that will be applied to the output of the controller when Autotune is initiated. This step must be large enough to result in a PV change of at least 2.5% of span. Use as large a step as possible. ATTENTION The process can be tuned using either an upscale or downscale step change.
5	Exit Configuration mode	LOWR DISP	once to exit Configuration mode.

Continued on next page

5.17 Autotune, Continued

Starting Autotune

How you ready the controller to start Autotune depends on what type step change you have selected

- ASTP (automatic step change)
  - let the controller PV line out (PV = SP)
- MSTP (manual step change)
  - make sure you have selected an output step change value that will result in a PV change of at least 2.5% (See OUTSTP" on previous page)
  - let the controller PV line out (PV = SP)
- Use the procedure in Table 5-35 to start Autotune.

Table 5-35 Starting Autotune

Step	Operation	Press	Action
1	Start Autotune	AUTO TUNE	The Autotune algorithm automatically introduces the output step change (Manual - MSTP or Automatic - ASTP) onto the process. "TUNE" appears in the upper display to indicate that the Autotune is in progress. You will see: Upper Display — "A" alternating with the value of PV Lower Display — SP and the setpoint value

ATTENTION The output value upon which the output step is based is not the instantaneously displayed output value, but an internal averaged value of the output.

Reasons for Abort

The algorithm samples the step response of the process until that response has lined out. The line out time depends on the process reaction time.

- if no line-out has occurred after 48.54 hours of sampling
- in "Auto Step", if the resultant PV step is less than 2.5%.

Viewing the Remaining Samples

You can view the remaining number of samples left in the most recently initiated time window. (See "STEP RESPONSE SAMPLING") on the next page.

Press the LOWR DISP key until you see "SAM" and the number of samples counting down in the current time window in the lower display.

Continued on next page

5.17 Autotune, continued

Step Response Sampling

When Autotune is initiated, the controller output is step changed. The algorithm samples the step response of the process until the response has lined out (PV stabilized). The line-out time depends on the process reaction time.

Time Window

A time window is the time it takes for the algorithm to sample the step response of the process for line-out. The first time window takes 256 PV samples at the rate of one every 1/3 second. The lower display counts down from 256 until it reaches 0 (total time elapsed = 85-1/3 seconds) at which time the algorithm checks for the line-out. If the line-out has not occurred, another time window takes 128 samples at a rate of one every 2/3 second. The lower display counts down from 128 until it reaches 0 (total time elapsed for two windows = 170-2/3 seconds) and again checks for line-out. If there is no line-out, a third window of 128 samples, at 1-1/3 seconds each, is initiated. As long as there is no line-out, this time windowing will continue 9 more times, each time sampling at a lower rate. See Table 5-36 to determine what time window the controller is displaying. By determining how long one sample takes (column C in Table 5-36), you can find out what time window the controller is displaying (column A) and how long the time window will last (column D).

Example

If one sample takes 42-2/3 seconds then the Autotune algorithm is in the #8 time window and will take 91 minutes to complete. At the end of window #8 the total time elapsed for all windows is 3.03 hours. If the line-out has not occurred after the 12th window (48.54 hours) the Autotune will abort.

Time Window Samples

Table 5-36 lists the window number, number of samples, sampling time, window time and total time window.

Table 5-36 Time Windows

A	B	C	D	E
Window Number	Total Samples*	Sampling Time	Time for This Window	Total Time Window
1	256	1/3 sec	85-11/3 sec	85-1/3 sec
2	128	2/3 sec	85-1/3 sec	170-2/3
3	128	1-1/3 sec	170-2/3 sec	341-1/3 sec
4	128	2-2/3	341-2/3 sec	11-1/4 min
5	128	5-1/3	11-1/4 min	22.7 min
6	128	10-1/3 sec	22.7 min	45.5 min
7	128	21-1/3	45.5 min	91.0 min
8	128	42-2/3 sec	91.0 min	3.03 hrs
9	128	85-1/3 sec	3.03 hrs	6.07 hrs
10	128	170-2/3 sec	6.07 hrs	12.14 hrs
11	128	341-1/3 sec	12.14 hrs	24.27 hrs
12	128	682-2/3 sec	24.27 hrs	48.54 hrs

* The lower display indicates the number of samples remaining in the present window number.

5.17 Autotune, *Continued*

"SHORT TUNE" feature

This feature lets you obtain approximate tuning constants by prematurely implementing the Autotune calculation before the PV has fully lined-out during the Autotune process. This typically results in a different Gain value, however, Rate and Reset time will be relatively close to the optimally calculated value. You can then increase gain by a factor of 2 to 4 until an acceptable stable closed loop response is achieved – all in a short time – without prior process knowledge or trial and error guesswork.

Implementing Short Tune

After implementing the Autotune process, press the [AUTOTUNE] key while the controller is sampling the process response. "A" in the upper display will start to blink acknowledging the short tune procedure.
At the end of the time window (when lower display SAM = 0), the Autotune algorithm calculates constants based on the PV response up to that time, if the PV has changed by at least 2.5% of span.

Error code accessing procedure

When an error is detected in the Autotune process, the message "ABORT" appears in the lower display.
Access function prompt "AT ERROR" to determine what is causing the error. This procedure is listed in Table 5-37.

Table 5-37 Procedure for Accessing Autotune Error Codes

Step	Operation	Press	Action
1	Select Autotune Set Up Group	[SET UP]	Until you see: Upper Display [SET UP] Lower Display [AUTOTUNE]
2	Go to Error Code Prompt	[FUNC]	You will see: Upper Display [ ] ← An error code Lower Display [AT ERROR] Table 5-38 lists all the Autotune error codes, their definitions, and how to correct the problem.

Continued on next page

Error Codes

Table 5-38 lists the Autotune error codes, their definitions, and what to do about the error.

Table 5-38 AUTOTUNE Error Code Definitions

Error Code (Upper Display)	Definition	Action to Take
OUTLIM	OUTPUT GREATER THAN HIGH OUTPUT LIMIT OR LESS THAN LOW OUTPUT LIMIT	• Check the output limits under "CONTROL" function prompts "OUTHILIM" and "OUTLOLIM." See *Section 3 - Configuration.* • If you are using a manual step change, reconfigure "OUTSTEP" prompt under AUTOTUNE group. • Restart Autotune procedure.
DUPLIM	OUTPUT GREATER OR LESS THAN THE HEAT/COOL LIMITS The step entered cool zone when tuning heat, or the step entered heat zone when tuning cool.	• Reconfigure the step size to fall only within heat or cool zone. Autotune function prompt "OUTSTEP." • Restart Autotune procedure.
ALARM 1	ALARM 1 LIMIT EXCEEDED Alarm 1 error code will show if you have configured alarm 1 to activate at a value of a parameter and it is exceeded.	• Check alarm type and limit under "ALARM" function prompts "A1S1VAL" and "A1S1TYPE." • Reconfigure smaller step size. • Restart Autotune procedure.
LOW PV	PV CHANGE NOT GREATER THAN 2.5% The algorithm has sampled the process step response for a period of time (48 hours max.) and the PV has lined out with less than a 2.5% change.	• Reconfigure to MSTEP and use a larger step size "AUTOTUNE" function prompt "OUTSTEP." • Restart Autotune procedure.
IDFAIL	PROCESS IDENTIFICATION FAILURE Autotune has aborted due to either excessive noise or a step response interruption, or because the process cannot be tuned.	• Excessive noise - reconfigure larger step size "AUTOTUNE" function prompt "OUTSTEP." • *Step response interruption* - make sure interruption is not repeated. - restart Autotune procedure. • Untunable process – contact local application engineer.
_I_LIM	RESET LIMITS EXCEEDED The reset value has exceeded high or low limits. The unit will control at high or low limits. Low = 0.02 minutes High = 50.0 minutes	• Increase or decrease PB or Gain to bring reset within the defined limits. • Check the final control element for proper application. • Untunable process – contact local application engineer.

Table 5-38 is continued on next page

Table 5-38 AUTOTUNE Error Code Definitions, Continued

Error Code (Upper Display)	Definition	Action to Take
_P_LIM	GAIN LIMITS EXCEEDED The Gain value has exceeded high or low limits. The unit will control a. high or low limits, Low = 0.1 High = 999.9	• Increase or decrease Reset to bring Gain or PB to within defined limits. • Check the final control element for proper application. • Untunable process – contact local application engineer.
ABORT	MANUAL ABORT Autotune has been manually aborted.	• Autotune will abort if the [MAN/AUTO] key is pressed during Autotune.
INPUT	INPUT ERROR An input is outside of its 0 to 100 % range, or any input failed.	• Make sure the range and actuation are configured properly. • Check the input source(s).
RAMP	AUTOTUNE ILLEGAL DURING RAMP OR SET POINT PROGRAM.	• Wait until Ramp or program is complete and restart Autotune.
RMSW	AUTOTUNE IS ABORTED WHEN EXTERNAL SWITCH IS DETECTED	• Restart Autotune – Do not interrupt with digital input (Remote Switching) contact closure.

Aborting Autotune

To abort Autotune and return to the last previous operation (SP or output level), press [MAN/AUTO] key to abort the Autotune process.

- Autotune will automatically abort if alarm and setpoint are exceeded or if the Autotune procedure requires more than 12 windows.

Completing Autotune

When Autotune is complete -

- the calculated tuning parameters are stored in their proper memory location in the controller, and
- the controller will control at the local setpoint using the newly calculated tuning constants.

Section 6 – Setpoint Ramp/Soak Programming Option

6.1 Overview

What is programming?

The term "programming" is used here to identify the process for selecting and entering the individual ramp and soak segment data needed to generate the required setpoint versus time profile (also called a program).

A segment is a ramp or soak function which together make up a setpoint program. Setpoint Ramp/Soak Programming lets you configure 10 ramp and 10 soak segments to be stored for use as one program or several small programs. You designate the beginning and end segments to determine where the program is to start and stop.

Review program data and configuration

While the procedure for programming is straightforward, and aided by prompts, we suggest that you read *"Program Contents"* in this section as well as *"Section 4 - Configuration Prompt Definitions"* before doing the setpoint programming.

Fill out the worksheet

Draw a Ramp/Soak Profile on the worksheet provided and fill in the information for each segment. This will give you a record of how the program was developed.

What's in this section

The table below lists the topics that are covered in this section.

6.2 Program Contents

What you will configure

Basically, you will configure all the data that is relevant to each ramp and soak segment for a given setpoint versus time profile. The controller will prompt you through the sequence of segments and associated functions.

Ramp segments

A ramp segment is the time it will take to change the setpoint to the next setpoint value in the program.

Ramps are odd number segments. Segment #1 will be the initial ramp time.

Ramp time is determined in either:

TIME* - Hours:Minutes   Range = 0-99hrs:59 min.

or

RATE* - Degrees/Minute   Range = 0 to 999

* This selection of time or rate is made at prompt "RAMP UNIT"

Set this prompt before entering any Ramp.

ATTENTION Entering "0" will imply an immediate step change in setpoint to the next soak.

Soak segments

A soak segment is a combination of a soak setpoint (value) and a soak duration (time).

Soaks are even number segments.

Segment 2 will be the initial soak value and soak time.

The soak setpoint range value must be within the setpoint high and low range limits in engineering units.

SOAK TIME is the duration of the soak and is determined in:

TIME - Hours:Minutes   RANGE = 0-99hrs:59 min.

Start segment number

This designates the number of the first segment.

Range = 1 to 19

End segment number

This designates the number of the last segment. It must be a soak segment (even number).

Range = 2 to 20

Recycle number

This number allows the program to recycle a specified number of times from beginning to end.

Range = 0 to 99

Continued on next page

Guaranteed Soak

Each soak segment can have a deviation value of from 0 to ±99 which guarantees the value for that segment.

Guaranteed soak segment values >0 guarantee that the segments process variable is within the ± deviation for the configured soak time. Whenever the ± deviation is exceeded, soak timing is frozen.

There are no guaranteed soaks whenever the deviation value is configured to 0, i.e., soak segments start timing soak duration as soon as the soak setpoint is first reached, regardless of where the process variable remains relative to the soak segment.

The value is the number in engineering units, above or below the setpoint, outside of which the timer halts. The range is 0 to ± 99.

The decimal location corresponds to input 1 decimal selection.

Program state

This selection determines the program state after completion.

The selections are:

DISABL = Program is disabled

HOLD = Program on hold (RUN key restarts the program)

Program termination state

This function determines the status of the controller upon completion.

The selections are:

LAST SP = controls to last setpoint and last control mode

F SAFE = Manual mode, Failsafe Output

ATTENTION If power is lost during a program, upon power-up the controller will be in hold and the setpoint value will be the setpoint value prior to the beginning of the setpoint program. The program is placed in hold at the beginning of the first segment in the program.

Ramp unit

This determines the engineering units for the ramp segments.

The selections are:

TIME = Hours:Minutes

RATE = Degrees/Minutes

ATTENTION This selection cannot be changed while a program is in operation.

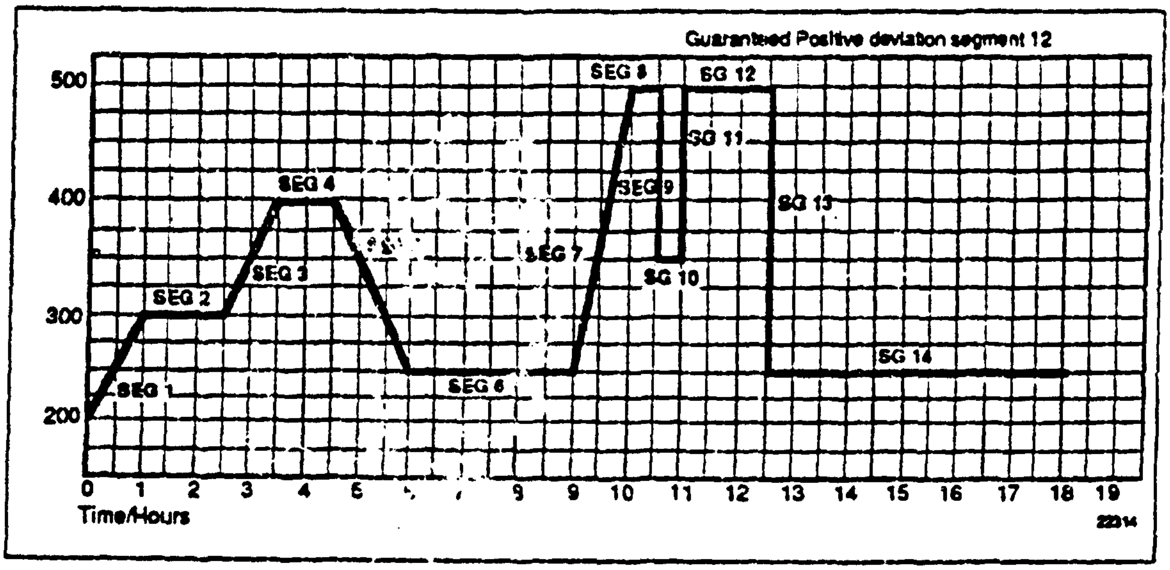
6.3 Drawing a Ramp/Soak Profile

Ramp/Soak Profile example

Before you do the actual configuration, we recommend that you draw a Ramp/Soak profile in the space provided on the *"Program Record Sheet"* (Figure 6-2) and fill in the associated information.

An example of a Ramp/Soak Profile is shown in Figure 6-1.

Figure 6-1 Ramp/Soak Profile Example



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6.3 Drawing a Ramp/Soak Profile, Continued

Ramp/Soak Profile example, continued

Figure 6-1 Ramp/Soak Profile Example, continued

Prompt	Function	Segment	Value	Prompt	Function	Segment	Value
STRT SEG	Start Seg.		1	SG12 SP	Soak SP	12	500
END SEG	End Seg.		14	SG12TIME	Soak Time	12	1hr.:30 min.
RECYCLES	Number of Recycles		2	SG13RAMP	Ramp Time	13	0
SEG1RAMP	Ramp Time	1	1 hr.	SG14 SP	Soak SP	14	250
SEG2 SP	Soak SP	2	300	SG14TIME	Soak Time	14	5hr.:30 min.
SEG2TIME	Soak Time	2	1hr.:30 min.	SG15RAMP	Ramp Time	15	
SEG3RAMP	Ramp Time	3	1hr.	SG16SP	Soak SP	16	
SEG4 SP	Soak SP	4	400	SG16TIME	Soak Time	16	
SEG4TIME	Soak Time	4	1 hr.	SG17RAMP	Ramp Time	17	
SEG5RAMP	Ramp Time	5	1hr.:30 min.	SG18 SP	Soak SP	18	
SEG6 SP	Soak SP	6	250	SG18 TIME	Soak Time	18	
SEG6TIME	Soak Time	6	3hrs.:0min.	SG19RAMP	Ramp Time	19	
SEG7RAMP	Ramp Time	7	1 hr.	SG20SP	Soak SP	20	
SEG8 SP	Soak SP	8	500	SG20 TIME	Soak Time	20	
SEG8TIME	Soak Time	8	2hr.:30 min.	GUAR SOAK	Guaranteed Soak Deviation	SKDEV + 12	5
SEG9RAMP	Ramp Time	9	0	PROG END	Controller Status		LAST SP
SG10 SP	Soak SP	10	350	STATE	Controller State at end		HOLD
SG10 TIME	Soak Time	10	0hr.:30 min.	POWER UP	Power Outage		RESUME
SG11RAMP	Ramp Time	11	0	RAMP UNIT	Engr. Unit for Ramp		TIME

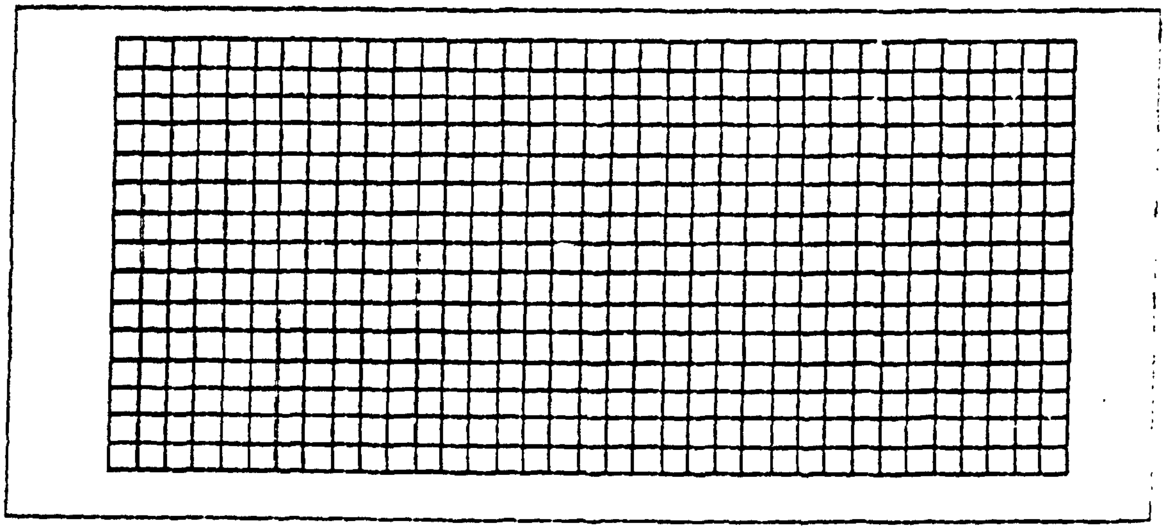
Continued on next page

6.3 Drawing a Ramp/Soak Profile, Continued

Program Record Sheet

Draw your ramp/soak profile on the record sheet shown in Figure 6-2 and fill in the associated information in the blocks provided on the next page. This will give you a permanent record of your program and will assist you when entering the Setpoint data.

Figure 6-2 Program Record Sheet



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Program Record Sheet, continued

Figure 6-2 Program Record Sheet, Continued

Prompt	Function	Segment	Value	Prompt	Function	Segment	Value
STRT SEG	Start Seg.			SG12 SP	Soak SP	12	
END SEG	End Seg.			SG12TIME	Soak Time	12	
RECYCLES	Number of Recycles			SG13RAMP	Ramp Time	13	
SEG1RAMP	Ramp Time	1		SG14 SP	Soak SP	14	
SEG2 SP	Soak SP	2		SG14TIME	Soak Time	14	
SEG2TIME	Soak Time	2		SG15RAMP	Ramp Time	15	
SEG3RAMP	Ramp Time	3		SG16SP	Soak SP	16	
SEG4 SP	Soak SP	4		SG16TIME	Soak Time	16	
SEG4TIME	Soak Time	4		SG17RAMP	Ramp Time	17	
SEG5RAMP	Ramp Time	5		SG18 SP	Soak SP	18	
SEG6 SP	Soak SP	6		SG18 TIME	Soak Time	18	
SEG6TIME	Soak Time	6		SG19RAMP	Ramp Time	19	
SEG7RAMP	Ramp Time	7		SG20SP	Soak SP	20	
SEG8 SP	Soak SP	8		SG20 TIME	Soak Time	20	
SEG8TIME	Soak Time	8		GUAR SOAK	Guaranteed Soak Deviation		
SEG9RAMP	Ramp Time	9		PROG END	Controller Status		
SG10 SP	Soak SP	10		STATE	Controller State at end		
SG10 TIME	Soak Time	10		POWER UP	Power Outage		
SG11RAMP	Ramp Time	11		RAMP UNIT	Engr. Unit for Ramp		

6.4 Entering the Setpoint Program Data

Introduction

The procedure listed in table 6-1 tells you what keys to press and what prompts you will see when entering the setpoint program data. Follow the prompt hierarchy listed in table 6-2 when selecting the functions for setpoint programming.

ATTENTION Make sure SP RAMP is disabled first.

Table 6-1 Setpoint Program Data Entry Procedure

Step	Action	Press	Result
1	Select SP Ramp Group	SET UP until you see	Upper Display SET UP Lower Display SP RAMP
2	Select SP PROG Group	FUNC until you see	Upper Display ← ENABLE ENABL2 ENABL12 Lower Display SP PROG
		▲ or ▼	to enable the setpoint programming option on Loop 1, Loop 2, or both.
3	Select the functions	FUNC	This accesses the function prompts for SP Programming. Upper Display ← Shows current value for each prompt Lower Display ← The individual function prompts within the setpoint program group are shown. Successive presses of the [FUNCTION] key will sequentially display all the functions and their values or selections. Follow the prompt hierarchy shown in table 6-2.
4	Change the value or selection of a function prompt	▲ or ▼	This changes the value or selection in the upper display. If the display blinks, you are trying to select an unacceptable value.
5	Enter Value or selection into memory	FUNC	This enters the value or selection and goes to another prompt. Repeat steps 4 and 5 for each function you want to change.
6	Exit configuration	LOWR DISP	This exits from the configuration mode.

Alarms on the Setpoint Program

You can configure an event to go ON or OFF at the beginning or end of any segment. Refer to *Section 3 - Configuration* under *"Alarms Parameters Group"* for details.

Continued on next page

Prompt Hierarchy

Table 6-2 lists all the function prompts for Setpoint Program data configuration in the order of their appearance.
Follow the procedure in Table 6-1 to transfer the data from your setpoint Ramp/Soak profile into the controller.
All parameters may be changed while program is disabled or in HOLD.

Table 6-2 Prompt Hierarchy and Available Selections

Prompt (Lower Display)	Definition	Value or Selection (use ▲ or ▼) (Upper Display)
SP RAMP	Setpoint Ramp selection	*Selections*: DISABLE **SP RAMP must be disabled to allow Setpoint Programming.**
SP PROG	Setpoint Ramp/Soak Programming	*Selections*: DISABL ENABLE - Loop 1 ENABL2 - Loop 2 ENABL12 - Loop 1 and 2 **SP PROG must be enabled to view the remaining prompts.**
STRT SEG	Start Segment Number	*Enter Value*: 1 to 19
END SEG	End Segment Number	*Enter Value*: 2 to 20 Always end in a soak Segment (2,4,.....20)
RECYCLES	Number of Program Recycles	*Enter Value*: 0 to 99 recycles
SEG1RAMP	Segment #1 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min **Select HRS:MIN or DEG/MIN at prompt "RAMP UNIT".** **All ramps will use the same selection.**
SEG2 SP	Segment #2 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SEG2TIME	Segment #2 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SEG3RAMP	Segment #3 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SEG4 SP	Segment #4 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SEG4TIME	Segment #4 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SEG5RAMP	Segment #5 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min

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Prompt Hierarchy (continued)

Table 6-2 Prompt Hierarchy and Available Selections, continued

Prompt	Definition	Value or Selection (use ▲ or ▼)
SEG6 SP	Segment #6 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SEG6TIME	Segment #6 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SEG7RAMP	Segment #7 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SEG8 SP	Segment #8 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SEG8TIME	Segment #8 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SEG9RAMP	Segment #9 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SG10 SP	Segment #10 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SG10TIME	Segment #10 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SG11RAMP	Segment #11 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SG12 SP	Segment #12 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SG12TIME	Segment #12 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SG13RAMP	Segment #13 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SG14 SP	Segment #14 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SG14TIME	Segment #14 Soak Duration	*Enter Value*: 0-99hrs:0-59min
SG15RAMP	Segment #15 Ramp Time	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SG16 SP	Segment #16 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
SG16TIME	Segment #16 Soak Duration	*Enter Value*: 0-99hrs:0-59min

Table 6-2 continued on next page

Prompt Hierarchy (continued)

Table 6-2 Prompt Hierarchy and Available Selections, continued

Prompt	Definition	Value or Selection (use ▲ or ▼)
SG17RAMP	Segment #17 Ramp Time	*Enter Value:* Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SG18 SP	Segment #18 Soak Setpoint Value	*Enter Value:* Within the Setpoint limits
SG18TIME	Segment #18 Soak Duration	*Enter Value:* 0-99hrs:0-59min
SG19RAMP	Segment #19 Ramp Time	*Enter Value:* Ramp Time = 0-99hrs:0-59min, or 0-999 degrees/min
SG20 SP	Segment #20 Soak Setpoint Value	*Enter Value:* Within the Setpoint limits
SG20TIME	Segment #20 Soak Duration	*Enter Value:* 0-99hrs:0-59min
GUARSOAK	Guaranteed Soak Deviation	*Selections:* ENABLE DISABL If enabled, you can select a positive or negative deviation for all soak segments. See next prompt.
SKDEV+XX or SKDEV–XX	Guaranteed Soak Positive or Negative Deviation Value	*Enter Value:* 0 to ± 99 The number selected will be 0 to 99± from setpoint.
STATE	Program state at program end	*Selections:* DISABLE HOLD(hold mode)
PROG END	Program Termination State	*Selections:* LAST SP - Hold at last setpoint in the program F SAFE - Manual mode/Failsafe output
POWER UP	Program Status at Power up from Power Outage	*Selections:* ABORT RESUME RESTART
RAMPUNIT	Engineering units for ramp segments	*Selections:* TIME RATE

6.5 Run/Monitor the Program

Introduction

Make sure all the "SP PROG" function prompts under the Set Up group "SP RAMP" have been configured with the required data.
An "H" will appear in the upper display indicating that the program is in the HOLD state.

Run/Monitor functions

Table 6-3 lists all the functions required to run and monitor the program.

Table 6-3 Run/Monitor Functions

Function	Press	Result
Set the Local Setpoint	SP1 SP2	You will see Upper Display: ← Local Setpoint Value Lower Display: SP
	▲ or ▼	To set the Local Setpoint value to where you want the program to start out.
Run State	RUN HOLD	Initiates the setpoint program. An "R" appears in the upper display indicating that the program is running.
Hold State	RUN HOLD	Holds the setpoint program. An "H" appears in the upper display indicating that the program is in the HOLD state. The setpoint holds at the current setpoint.
External Hold		If Remote Switching is present on your controller, contact closure places the controller in the HOLD state, if the setpoint program is running. The "H" in the upper display will blink. ATTENTION The keyboard takes priority over external switch for the RUN/HOLD function. Contact reopening runs program.
Changing a Segment while in Hold	▲ or ▼	These keys will operate and allow you to change the segment number while in HOLD. If a different segment is selected, it will be started at the beginning when placed in RUN. If the original segment is brought back, it will continue from the point placed in HOLD. NOTE: changing a segment number may affect the alarms/events.

Continued on next page

6.5 Run/Monitor the Program, Continued

Run/Monitor functions (continued)

Table 6-3 Run/Monitor Functions, continued

Function	Press	Result
Viewing the present ramp or soak segment number and time	LOWR DISP until you see	Upper Display ← "R" and the PV value Lower Display For Ramp segments: # RA XX.XX Ramp Time - Hours:Minutes or Ramp Rate - Degrees/Minute Indicates Ramp segment Segment Number (odd only) For Soak segments: # SK XX.XX Time remaining in segment in Hrs:Minutes including current partially completed minute Indicates Soak segment Segment Number (even only)
Viewing the number of cycles left in the program	LOWR DISP until you see	Upper Display ← "R" and the PV value Lower Display RECYC XX Remaining Cycles 0 to 99 This number includes the current partially completed cycle.
End Program		When the final segment is completed, the "R" in the upper display either changes to "H" if configured for HOLD state, or disappears if configured for disable of setpoint programming. The controller operates at the last setpoint in the program in automatic or will be in manual mode at the failsafe output.

Power-up state

The program will be placed in HOLD mode at the beginning of the program at the local Setpoint value prior to the beginning of the program.

Section 7 – Input Calibration

7.1 Overview

Introduction

This section describes the field calibration procedures for Input 1, Input 2, and Optional Input 3.
Every UDC5000 controller contains all input actuation ranges fully factory calibrated and ready for configuration to range by the user.
However these procedures can be implemented if the factory calibration of the desired range is not within specifications.
Note that the field calibration will be lost if a change in input type configuration is implemented at a later time. The original factory calibration data remains available for later use after a field calibration is done.

What's in this section

This section contains the following topics:

Calibration steps

Use the following steps when calibrating an input.

Step	Action
1	Find the minimum and maximum range values for your PV input range from Table 7-1.
2	Disconnect the field wiring and find out what equipment you will need to calibrate. DO NOT remove external resistor assemblies (if present).
3	Wire the calibrating device to your controller according to the Set Up wiring instructions for your particular input.
4	Follow the calibration procedure given for Input #1, #2 or #3

7.2 Minimum and Maximum Range Values

Select the range values You should calibrate the controller for the minimum (0%) and Maximum (100%) range values of your particular sensor.
If you have a two input controller, calibrate each input separately.
Select the Voltage or Resistance equivalent for 0% and 100% range values from Table 7-1. Use these value when calibrating your controller.

Table 7-1 Voltage and Resistance Equivalents for 0% and 100% Range Values

Sensor Type	PV Input Range		Range Values	
	°F	°C	0%	100%
B Thermocouple	105 to 3300	41 to 1816	0 mV	13.763 mV
E Thermocouple	-454 to 1832	–270 to 1000	–9.835 mV	76.358 mV
E Thermocouple(Low)	-200 to 1100	–129 to 593	–6.471 mV	44.547 mV
J Thermocouple	0 to 1600	–18 to 871	–0.885 mV	50.059 mV
J Thermocouple(Low)	20 to 770	–7 to 410	–0.334 mV	22.397 mV
K Thermocouple	0 to 2400	–18 to 1316	–0.692 mV	52.939 mV
K Thermocouple(Low)	-20 to 1000	–29 to 538	–1.114 mV	22.251 mV
NiNiMoly T/C	32 to 2500	0 to 1371	–0.001 mV	71.330 mV
NiNiMoly (Low)	32 to 1260	0 to 682	–0.001 mV	31.820 mV
Nicrosil Nisil T/C	0 to 2372	–18 to 1300	–0.461 mV	47.502 mV
R Thermocouple	0 to 3100	–18 to 1704	–0.089 mV	20.275 mV
S Thermocouple	0 to 3100	–18 to 1704	–0.092 mV	17.993 mV
T Thermocouple	-300 to 700	–184 to 371	–5.341 mV	19.096 mV
T Thermocouple(Low)	-200 to 600	–129 to 316	–4.149 mV	15.769 mV
W5W26 T/C	0 to 4200	–18 to 2316	–0.234 mV	37.066 mV
W5W26 T/C(Low)	0 to 2240	–18 to 1227	–0.234 mV	22.277 mV
RTD (IEC=0.00385)				
100 Ohms	-300 to 900	–184 to 482	25.18 ohms	274.96 ohms
100 Ohms (low)	0 to 300	–18 to 149	93.03 ohms	156.90 ohms
200 Ohms	-300 to 900	–184 to 482	50.36 ohms	549.92 ohms
500 Ohms	-300 to 900	–184 to 482	125.90 ohms	1374.80 ohms
Radiamatic (RH)	1400 to 3400	760 to 1871	0.99 mV	57.12 mV
Carbon Probe	0 to 2.0% Carbon		0 mV	1250 mV
Relative Humidity	21 to 212	–6 to 100	97.65 Ohms	138.50 Ohms
Dew Point	–60 to 100	–46 to 38	0 mV	1250 mV
Oxygen Probe	0 to 40% Oxygen		–30 mV	510 mV
Linear				
Milliamps	4 to 20 mA		4 mA	20 mA
Millivolts	0 to 10 mV		0 mV	10 mV
	10 to 50 mV		10 mV	50 mV
Volts	1 to 5 Volts		1 Volt	5 Volts
	0 to 10 Volts		0 Volts	10 Volts

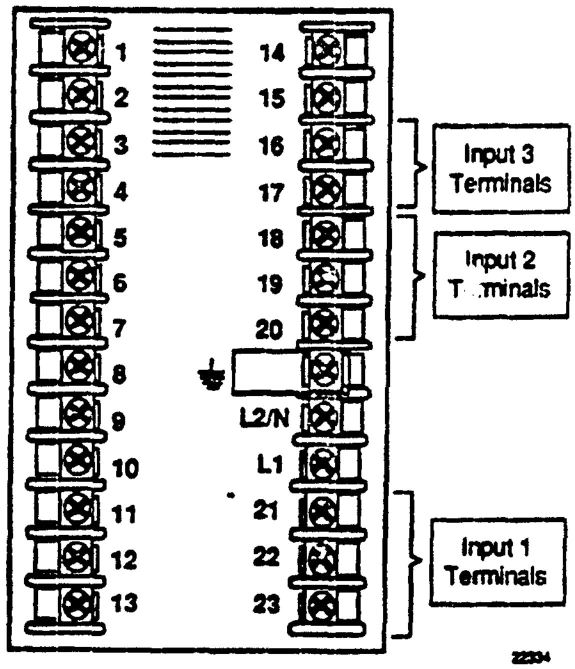
7.3 Inputs 1 and 2 Preliminary Information

Disconnect the field wiring

Depending on which input (#1 or 2) you are going to calibrate, tag and disconnect any field wiring connected to the input terminals on the rear of the controller.

Figure 7-1 shows the wiring terminal designations for Input #1 and #2.

Figure 7-1 Input #1 and #2 Wiring Terminals



Changing the input group type

When you change from some groups to others, (for example: 4–20mA to Thermocouple) you must adapt the input circuitry so that it will be compatible with the input signal. This includes configuration of an input type and the installation and removal of jumpers on the controller printed wiring board.

Refer to *Section 3 - Configuration* to select the input type and *Section 2 - Installation* to determine your jumper and resistor requirements.

Continued on next page

7.3 Inputs 1 and 2 Preliminary Information, Continued

Equipment needed

Table 7-2 lists the equipment you will need to calibrate the specific types of inputs that are listed in Table 7-1. You will need a screwdriver to connect these devices to your controller.

Table 7-2 Equipment Needed

Type of Input	Equipment Needed
Thermocouple Inputs (Ice Bath)	• A calibrating device with ±0.01% accuracy for use as a signal source such as a millivolt source. • Thermocouple extension wire that corresponds with the type of thermocouple that will be used with the controller input. • Two insulated copper leads for connecting the thermocouple extension wire from the ice baths to the precision calibrator. • Two containers of crushed ice.
Thermocouple Inputs (Precision Resistor)	• A calibrating device with ±0.01% accuracy for use as a signal source such as a millivolt source. • Two insulated copper leads for connecting the calibrator to the controller. • A precision 500 ohm resistor ±0.1% connected across input #5 terminals 1(R) and 3(−).
Thermocouple Inputs (Ambient Temperature)	• A calibrating device with ±0.02% accuracy for use as a signal source such as a millivolt source. • Two insulated copper leads for connecting the calibrator to the controller.
RTD (Resistance Thermometer Device) and Relative Humidity Inputs	• A decade box, with ±0.01% accuracy, capable of providing stepped resistance values over a minimum range of 0 to 1400 Ohms with a resolution of 0.1 ohm. • Three insulated copper leads for connecting the decade box to the controller.
Milliampere, Millivolt, Volts, Radiamatic, Carbon Potential Inputs, Dewpoint ranges, and Oxygen ranges.	• A calibrating device with ±0.01% accuracy for use as a signal source. • Two insulated copper leads for connecting the calibrator to the controller. • Place current source at zero before switching ON. • Do not switch current sources OFF/ON while connected to the UDC5000 input.

7.4 Inputs #1 and #2 Set Up Wiring

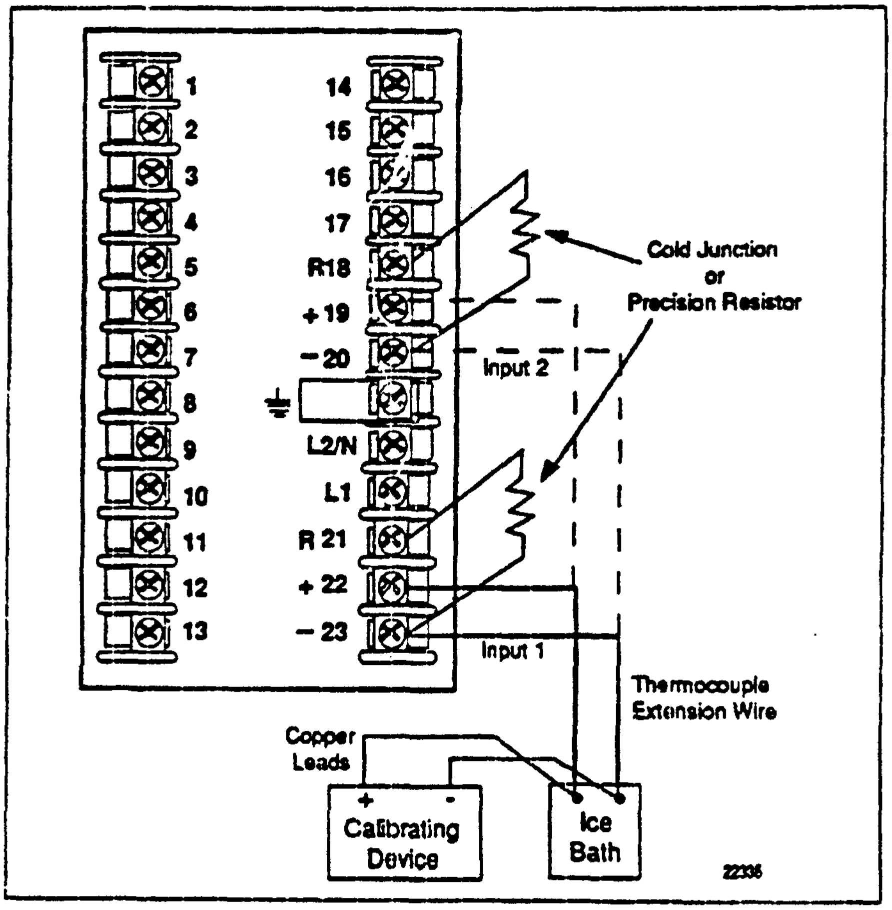
Thermocouple Inputs using an Ice bath

Refer to Figure 7-2 and wire the controller according to the procedure given in Table 7-3.

Table 7-3 Set Up Wiring Procedure for Thermocouple Inputs Using An Ice Bath

Step	Action
1	Connect the copper leads to the calibrator.
2	Connect a length of thermocouple extension wire to the end of each copper lead and insert the junction points into the ice bath.
3	Connect the thermocouple extension wires to the terminals for Input #1 or Input #2. See Figure 7-2.
4	Connect a Cold junction resistor between terminals 21 and 23 (Input #1) or terminals 18 and 20 (Input #2).

Figure 7-2 Wiring Connections for T/C Inputs Using an Ice Bath



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7.4 Inputs #1 and #2 Set Up Wiring, Continued

Thermocouple Inputs using a precision resistor

Refer to Figure 7-3 and wire the controller according to the procedure given in Table 7-4.

Table 7-4 Set Up Wiring Procedure for Thermocouple Inputs Using a Precision Resistor

Step	Action
1	Connect the copper leads to the calibrator.
2	Disconnect the cold junction resistor.
3	Install a 500 Ohm precision resistor across terminals 21 and 23 (Input #1) or terminals 18 and 20 (Input #2). See figure 7-3.
4	Subtract the millivolt value for 77°F (25°C) from the zero and span value for your range (see Table 7-1 for zero and span values) and use the adjusted value when calibrating. **ATTENTION** If a precision 500 Ohm resistor is not available, a resistor with a value of between 490 and 510 Ohms may be substituted with the following temperature correction: °C For each 0.2 ohms difference greater than 500 ohms, add 0.1 °C to both the T/C table and the cold junction setting. Likewise, for each 0.2 ohms difference less than 500 ohms, subtract 0.1 °C from both the T/C table and the C/J temperature. °F Same as °C, except 0.1 ohms/0.1°F. Accuracy for this method is limited to the accuracy of the resistance measurement.

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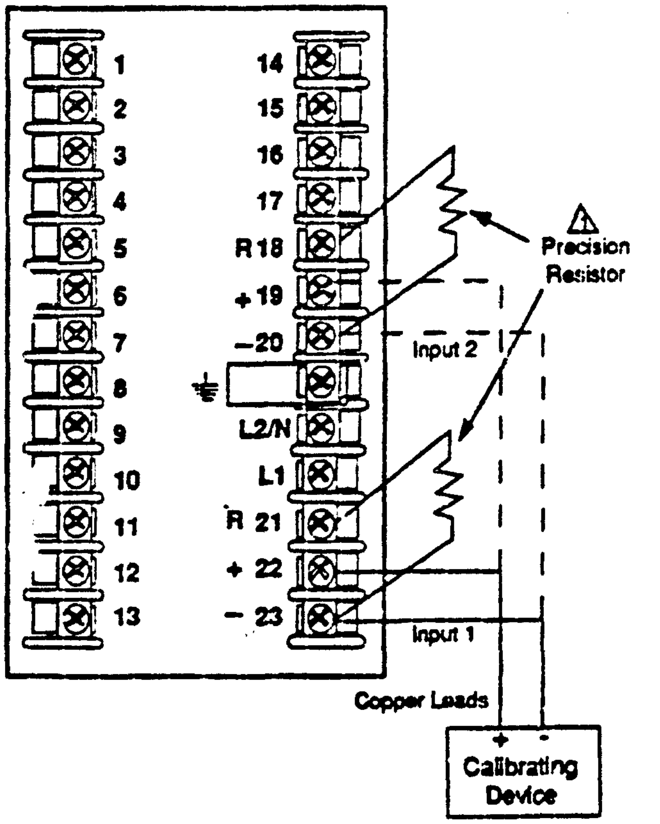
Thermocouple inputs using a precision resistor, continued

Figure 7-3 Wiring Connections for Thermocouple Inputs Using a Precision Resistor



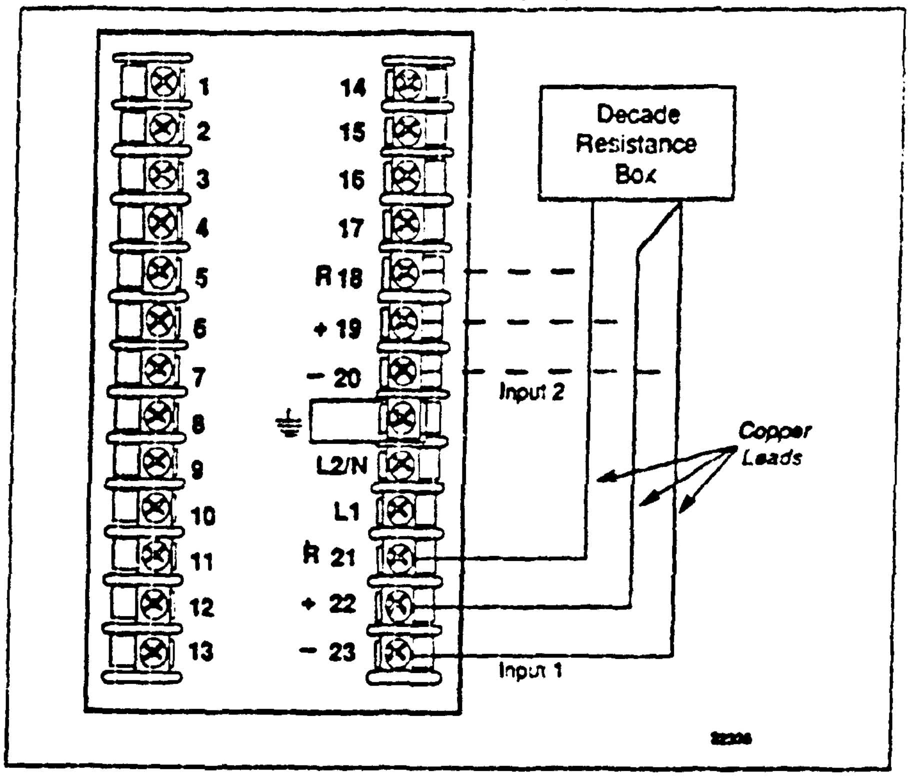
⚠ WARNING
The accuracy of the controller is directly affected by the accuracy of this resistor. At a minimum, use a 0.1% 25 PPM resistor.

Continued on next page

RTD Inputs or Relative Humidity Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #1 or #2. See Figure 7-4.

Figure 7-4 Wiring Connections for RTD (Resistance Thermometer Device) or Relative Humidity Inputs



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7.4 Inputs #1 and #2 Set Up Wiring, Continued

Radiamatic, Millivolts, Volts, milliamps inputs, Carbon Potential inputs, Dewpoint ranges, and oxygen ranges

Use the copper leads and connect the calibrator to the rear terminals of Input #1 or #2. See Figure 7-5.

Refer to Table 7-5 for additional information concerning these inputs and ranges.

Table 7-5 Calibration Information

Input or Range	Calibration Information
Transmitter Power Option	Use the wiring diagram for 4 to 20 mA, NO transmitter power; calibrate, then return the connections to those shown on the wiring diagram for 4 to 20 mA WITH transmitter power.
Radiamatic Inputs	Set the Emissivity for Input #1 or Input #2 to a value of 1.0. Refer to Section 3 - Configuration under SET UP prompt "INPUT 1" FUNCTION prompt "EMISSIVITY1" SET UP prompt "INPUT 2" FUNCTION prompt "EMISSIVITY2"
Carbon Potential Ranges	Calibrate Input #1 for any desired actuation type which will operate within the region of 900°F to 2000°F. Calibrate Input #2 for 0 to 1250 millivolts.
Dewpoint Ranges	Calibrate Input #1 for any desired actuation type which will operate within the region of 1000°F to 2200°F. Calibrate Input #2 for 0 to 1250 millivolts.
Oxygen Ranges	Calibrate Input #1 for any desired actuation type which will operate within the region of 800°F to 3000°F. Calibrate Input #2 for –30 to 510 millivolts.

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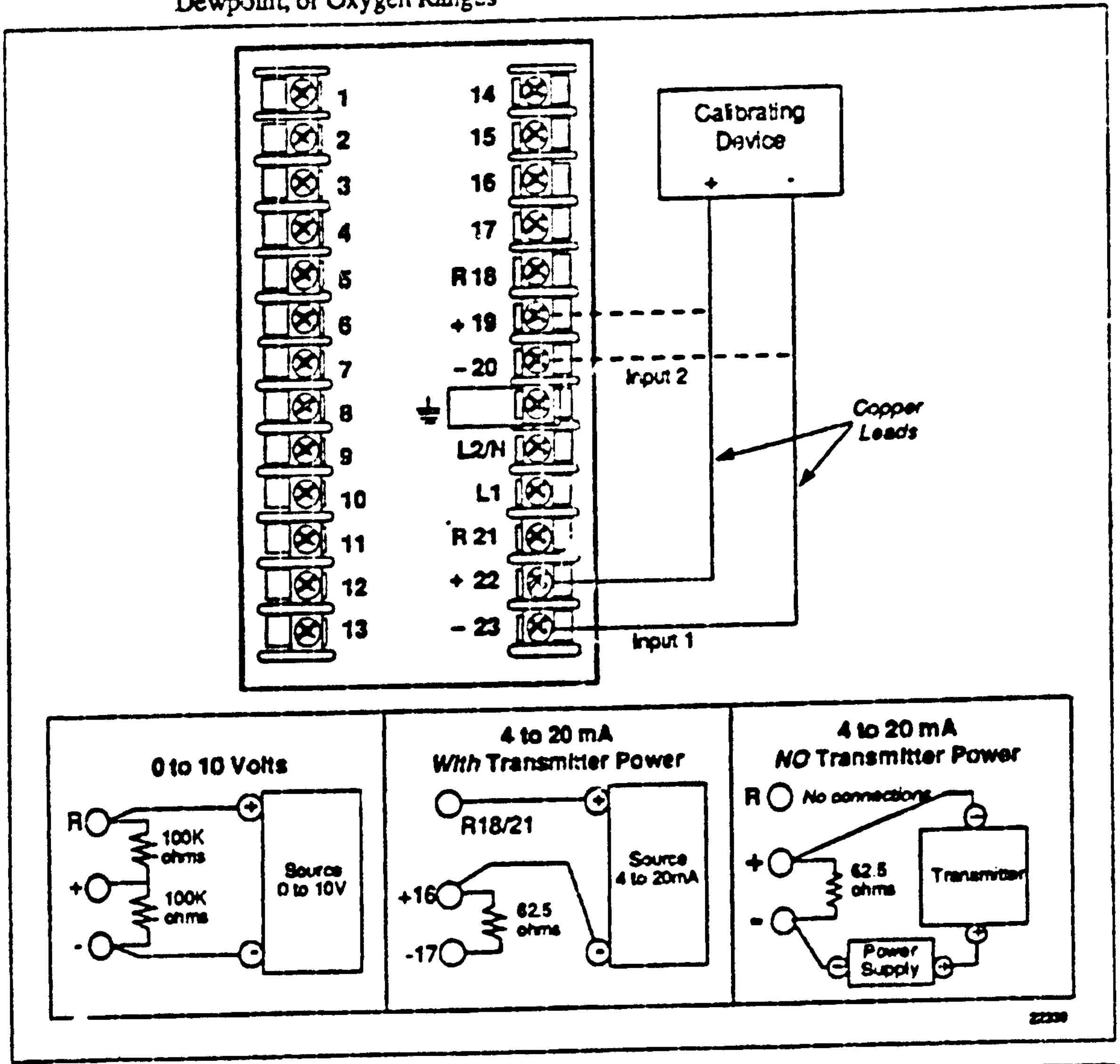
Radiamatic, Millivolts, Volts, milliamps Inputs, Carbon Potential Inputs, Dewpoint ranges, and oxygen ranges, continued

Figure 7-5 Wiring Connections for Radiamatic, Millivolts, Volts, Milliamps, Carbon Potential, Dewpoint, or Oxygen Ranges



7.5 Inputs #1 and #2 Calibration Procedure

Introduction

Apply power and allow the controller to warm up for 1 hour before you calibrate.
Please read "*Set Up Wiring*" before beginning the procedure.
Make sure you have "LOCKOUT" set to "NONE." See *Section 3 – Configuration*.

CAUTION For linear inputs, avoid step changes in inputs. Vary smoothly from initial value to final 100% value.

Procedure

The Calibration procedure is the same for Input #1 and #2 except that the displays will indicate 1 or 2. The procedure is listed in Table 7-6.

Table 7-6 Input #1 and #2 Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode for the Input selected	SET UP until you see	Upper Display: CALIB Lower Display: INPUT X X = 1 or 2
		FUNC	You will see: Upper Display: DISABL Lower Display: CAL INX X = 1 or 2
		▲	The calibration sequence is enabled and you will see: Upper Display: BEGIN Lower Display: CAL INX X = 1 or 2 At the completion of the sequence, the selection automatically reverts to disable.
2	Calibrate 0%	FUNC	You will see: Upper Display: APPLY Lower Display: INX ZERO X = 1 or 2 Adjust your calibration device to an output signal equal to the 0% range value for your particular input sensor. Wait 15 seconds, then go to the next step.

Table 7-6 continued on next page

Table 7-6 Input #1 and #2 Calibration Procedure, continued

<table>
<tr><th>Step</th><th>Description</th><th>Press</th><th>Action</th></tr>
<tr><td>3</td><td>Calibrate 100 %</td><td>FUNC</td><td>You will see:
Upper Display
APPLY
Lower Display
INX SPAN X = 1 or 2

Adjust your calibration device to an output signal equal to the 100% range value for your particular input sensor.

Wait 15 seconds, and
<table>
<tr><th>If...</th><th>Then...</th></tr>
<tr><td>you are calibrating a Thermocouple input</td><td>Go to step 4</td></tr>
<tr><td>you are calibrating other than a Thermocouple input</td><td>Go to step 5</td></tr>
</table></td></tr>
<tr><td>4</td><td>Check the Cold Junction Temperature

WARNING
The accuracy of the controller is directly affected by the accuracy of this value. Change this value only if the zero and span calibration procedures did not bring the controller within the specified accuracy requirements.</td><td>FUNC</td><td>The calculations for zero and span are now stored and you will see:
Upper Display
The cold junction temperature at the rear terminals
Lower Display
CJTEMP

Remove the cold junction resistor from rear terminals #21 and #23 and connect a precision 500 Ohm resistor in place of the cold junction.
Enter a value of 77.0 if the °F indicator is lit, or 25.0 if the °C indicator is lit.</td></tr>
<tr><td>5</td><td>Exit the Calibration Mode</td><td>FUNC
then
LOWR DISP</td><td>The controller will store the calibration constants and exit calibration mode.

To exit the calibration mode.</td></tr>
</table>

7.6 Input 3 Preliminary Information

Equipment needed

Table 7-7 lists the equipment you will need to calibrate the Milliamp or Volt ranges that are available for Input #3. You will need a screwdriver to connect these devices to your controller.

Table 7-7 Equipment Needed

Type of Input	Equipment Needed
Milliampere,or Volts	• A calibrating device with ±0.01% accuracy for use as a signal source. • Two insulated copper leads for connecting the calibrator to the controller. • Place current source at zero before switching ON. • Do not switch current sources OFF/ON while connected to the UDC5000 input.

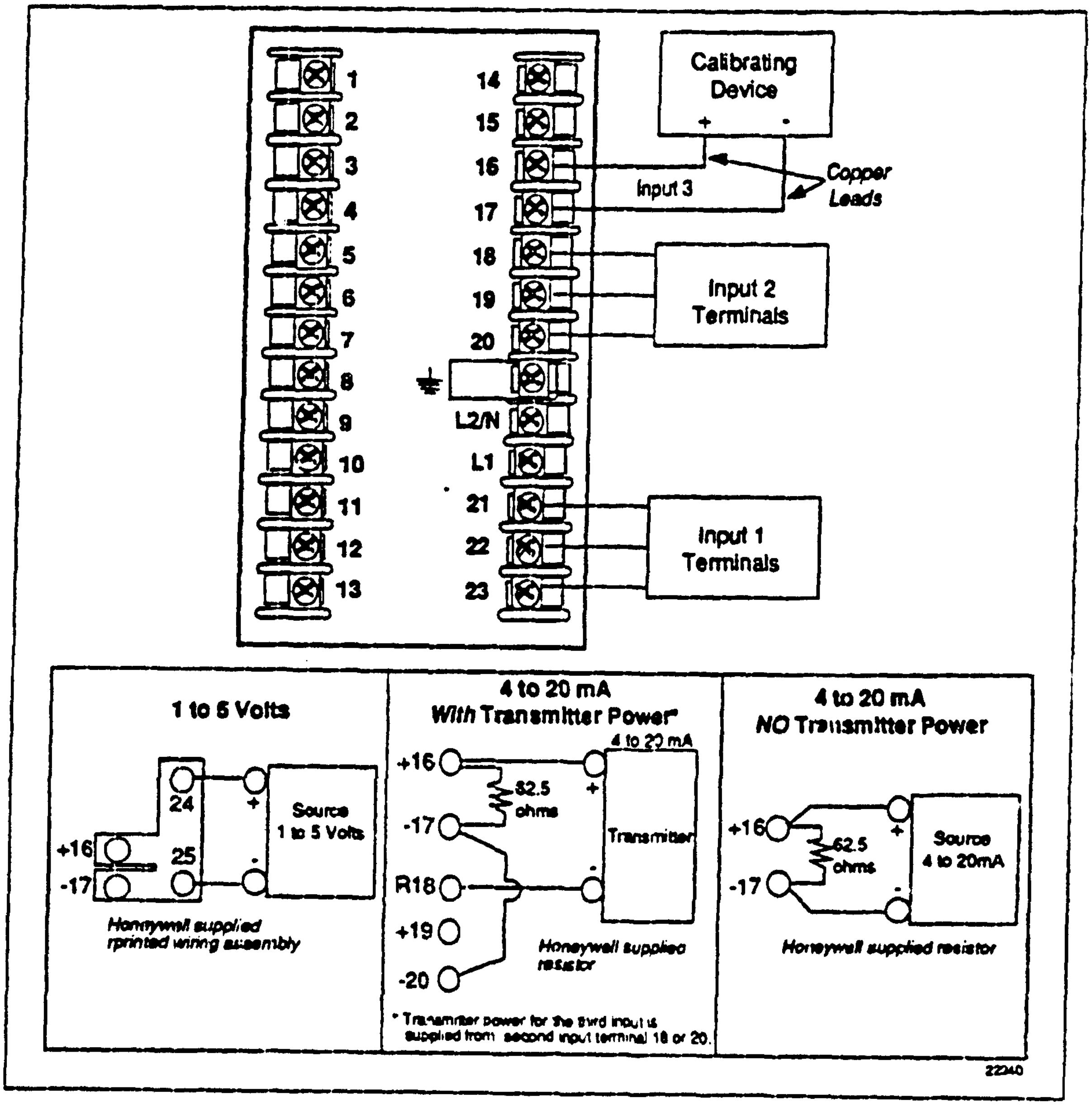
Continued on next page

7.7 Input 3 Set Up Wiring

1 to 5 Volts or 4–20 mA Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #3. See Figure 7-6.

Figure 7-6 Wiring Connections for 1 to 5 Volts or 4 to 20 mA



7.8 Input #3 Calibration Procedure

Introduction

Apply power and allow the controller to warm up for 1 hour before you calibrate.
Please read "*Set Up Wiring*" before beginning the procedure.
Make sure you have "LOCKOUT" set to "NONE." See *Section 3 – Configuration*.

CAUTION For linear inputs, avoid step changes in inputs. Vary smoothly from initial value to final 100% value.

Procedure

The Calibration procedure is listed in Table 7-8.

Table 7-8 Input #3 Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode for the Input selected	SET UP until you see	Upper Display: CALIB Lower Display: INPUT 3
		FUNC	You will see: Upper Display: DISABL Lower Display: CAL IN3
		▲	The calibration sequence is enabled and you will see: Upper Display: BEGIN Lower Display: CAL IN3 At the completion of the sequence, the selection automatically reverts to disable.
2	Calibrate 0%	FUNC	You will see: Upper Display: APPLY Lower Display: IN3 ZERO Adjust your calibration device to an output signal equal to the 0% range value for your particular input sensor. Wait 15 seconds, then go to the next step.

Table 7-8 continued on next page

7.8 Input #3 Calibration Procedure, Continued

Table 7-8 Input #3 Calibration Procedure, continued

Step	Description	Press	Action
3	Calibrate 100 %	FUNC	You will see: Upper Display APPLY Lower Display IN3 SPAN Adjust your calibration device to an output signal equal to the 100% range value for your particular input sensor.
4	Exit the Calibration Mode	FUNC or LOWR DISP	The controller will store the calibration constants and exit calibration mode. To exit the calibration mode

Section 8 – Output Calibration

8.1 Overview

Introduction

This section describes the field calibration procedures for the following types of outputs:

- Current Output
- Position Proportional and 3 Position Step Output
- Auxiliary Output

What's in this section

This section contains the following topics:

8.2 Current Proportional Output Calibration

Introduction

Calibrate the controller so that the output provides the proper amount of current over the desired range.
The controller can provide an output current range of from 0 to 21 milliamperes and can be calibrated at 4 mA for 0% of output and 20 mA for 100% of output or any other values between 0 and 21 mA.
ATTENTION We recommend that the expected output load be connected for optimum accuracy.

Equipment needed

You will need a standard shop type milliammeter, with whatever accuracy is required, capable of measuring 0 to 20 milliamps.

Calibrator connections

Refer to Figure 8-1 and wire the controller according to the procedure given in Table 8-1.

Table 8-1 Set Up Wiring Procedure Current Proportional Output

Step	Action
1	Apply power and allow the controller to warm up 15 minutes before you calibrate.
2	Tag and disconnect the field wiring, at the rear of the controller, from terminals 14(+) and 15(−). See Figure 8-1.
3	Connect a Milliammeter across these terminals. A load resistor equivalent to the process load should be connected in series with the millammeter.

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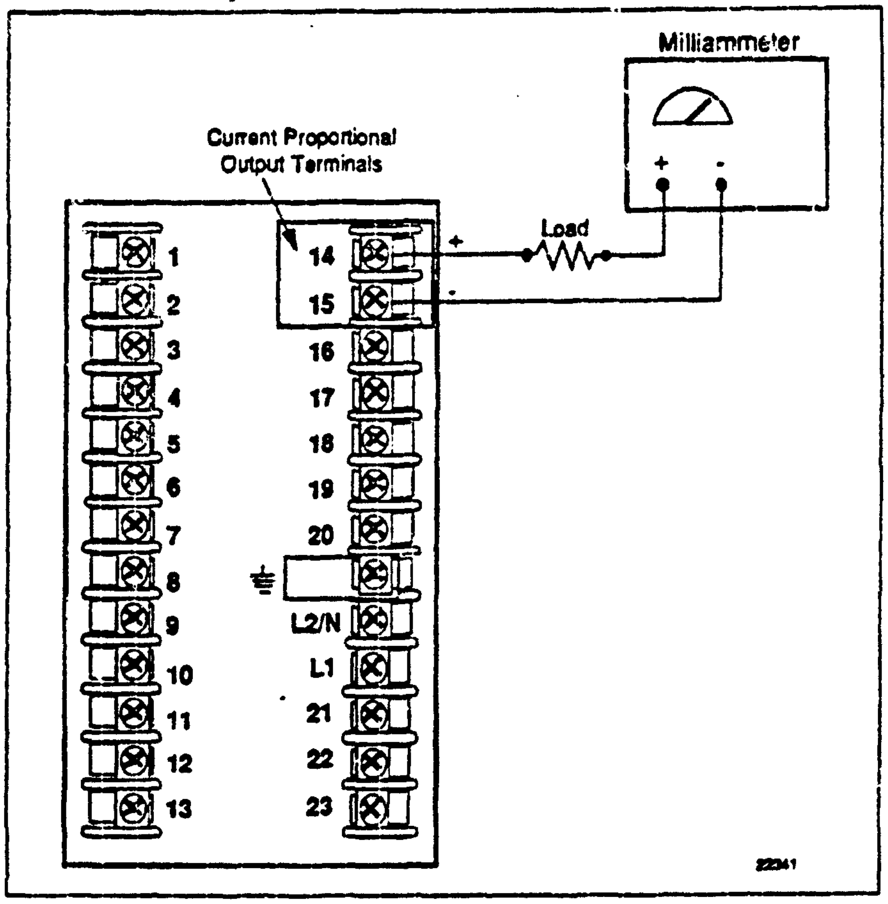
8.2 Current Proportional Output Calibration, continued

Calibrator connections, continued

Figure 8-1 Wiring Connections for Calibrating Current Proportional Output



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8.2 Current Proportional Output Calibration, Continued

Procedure The procedure for calibrating the Current Proportional Output is listed in Table 8-2. Make sure "LOCKOUT" in the Tuning Set Up group is set to "NONE." See *Section 3 – Configuration.*

Table 8-2 Current Proportional Output Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: CURRENT
2	Calibrate 0%	FUNC	You will see: Upper Display: [ ] ← a value between 1 and 2048 Lower Display: ZERO VAL
		▲ or ▼	until the desired 0% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 0 mA For 0 to 20 mA Direct Action* 20 mA For 0 to 20 mA Reverse Action 4 mA For 4 to 20 mA Direct Action 20 mA For 4 to 20 mA Reverse Action
3	Calibrate 100%	FUNC	This stores the 0%value and, You will see: Upper Display: [ ] ← a value between 1 and 2048 Lower Display: SPAN VAL
		▲ or ▼	until the desired 100% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 20 mA For 0 to 20 mA Direct Action 0 mA For 0 to 20 mA Reverse Action* 20 mA For 4 to 20 mA Direct Action 4 mA For 4 to 20 mA Reverse Action
4	Exit the Calibration Mode	FUNC	The controller will store the span value.
		LOWR DISP or SET UP	To exit the calibration mode. * When attempting to achieve 0 mA, always adjust the output to about 0.5 mA, and slowly decrease until the output just goes to zero. Further decrementing will not change the output current (since the circuit cannot produce negative current) but will affect the accuracy of the output by creating a dead zone where no current flows.

8.3 Position Proportional and Three Position Step Output Calibration

Position Proportional control

When the UDC 5000 controller has a Position Proportional control output, calibrate the controller so that the increase and decrease relays operate properly with respect to the position of the external feedback slidewire.

3 Position Step control

Three Position Step Control Output models with Motor Position Indication
This model must have its output calibrated per the entire procedure to ensure that the displayed output (slidewire position) agrees with the final control element position.
Three Position Step Control Output models without Motor Position Indication
This model only requires that the "Motor Time" be entered as shown in the calibration procedure. FULL CALIBRATION IS NOT REQUIRED.

Equipment needed

None

Connections

Apply power and allow the controller to warm up 15 minutes before you calibrate.
Leave all field wiring connected to the rear terminals.

Auto mode vs Manual mode

There are two ways in which to calibrate Position Proportional or 3 Position Step control:
AUTO mode or MANUAL mode.

Rules for Auto mode vs Manual mode

The Auto-mode selection must be done at least once before the manual mode will operate properly. Failure to use the Auto-mode procedure will prevent the controller from going into automatic control mode.

Displayed values

During the Auto-mode calibration procedure, the values being displayed are used only to indicate if the motor is still traveling.
To view the actual calibration value, use the manual mode after the Auto-mode is completed. These values can be changed for purposes of tweaking the calibration.

Continued on next page

8.3 Position Proportional and Three Position Step Output Calibration, Continued

Procedure

The procedure for calibrating the Position Proportional output and 3 Position Step control output is listed in table 8-3.

Make sure "LOCKOUT" in Tuning Set Up group is set to "NONE." See *Section 3 – Configuration*.

For *"Three Position Step Control Output models without Motor Position Indication"*, do steps 1 and 2 only.

For *"Position Proportional Output"* and *"Three Position Step Control Output models with Motor Position Indication"* follow the entire calibration procedure.

Table 8-3 Position Proportional and 3 Position Step Output Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: POS PROP
2	Set Motor Traverse Time Note: This is the time it takes the motor to travel from 0 to 100%.	FUNC	Until you see: Upper Display: a value Lower Display: MTR TIME
		or	Until the proper motor stroke time is reached (see the motor specs or measure the time) Range of setting = *Position Proportional* - 5 to 255 Seconds *3 Position Step* - 15 to 255 Seconds

Continued on next page

Table 8-3 Position Proportional and 3 Position Step Output Calibration Procedure, continued

Step	Description	Press	Action
3	Select Automatic or Manual Calibration	FUNC	until you see: Upper Display DISABLE Lower Display POS PROP You can calibrate the controller output manually or let the controller calibrate the output automatically. If the slidewire has never been calibrated, you must use "DO AUTO" first. In the "Automatic Calibration Mode" (DO AUTO), the controller relays automatically move the motor in the proper direction. If desired, however, the motor may be manually positioned to 0% and 100% positions. Disconnect the relay wires. "DO MAN". In the "Manual Calibration Mode" (DO MAN) the motor does not move. Instead, the existing 0% and 100% values may be changed with the ▲ or ▼ keys.
		▲ or ▼	to select automatic or manual calibration. Upper Display DO AUTO or DO MAN Lower Display POS PROP If you select DO AUTO, go to step 4 If you select DO MAN, go to step 6 Note: When calibration is terminated, this selection reverts to DISABL.
4	DO AUTO Set 100% value	FUNC	The decrement relay is turned on to move the motor to 100% position. Upper Display counts of feedback slidewire (0 to 1023) PLS WAIT then, Lower Display SPAN VAL When the motor stops, the display should stop counting, then, go on to next step. ATTENTION The controller may automatically recalibrate the span value a second time.

Continued on next page

8.3 Position Proportional and Three Position Step Output Calibration, Continued

Table 8-3 Position Proportional and 3 Position Step Output Calibration Procedure, continued

Step	Description	Press	Action
5	Set 0% value	FUNC	The increment relay is turned on to move the motor to 0% position. Upper Display [ ] ← counts of feedback slidewire (0 to 1023) PLS WAIT then, Lower Display ZERO VAL When the motor stops, the display should stop counting, then, go on to the step 8.
6	DO MAN Set 100% value	FUNC	You will see: Upper Display [ ] ← The existing span calibration value in counts Lower Display SPAN VAL
		▲ or ▼	until the desired span value is reached in the upper display. Upper Display [ ] ← The desired span value Lower Display SPAN VAL For manual calibration, the motor does not move from its position prior to the start of Position Proportional calibration.
7	Set 0% value	FUNC	The controller will store the 100% value and you will see: Upper Display [ ] ← The existing zero calibration value in counts. Lower Display ZERO VAL
		▲ or ▼	until the desired zero value is reached in the upper display. Upper Display [ ] ← The desired zero value Lower Display ZERO VAL
8	Exit the Calibration Mode	FUNC	The controller will store the 0% value.
		LOWR DISP or SET UP	To exit the calibration mode.

8.4 Auxiliary Output Calibration

Introduction

Calibrate the controller so that the Auxiliary output provides the proper amount of current over the desired range.

The controller can provide an auxiliary output current range of from 0 to 21 milliamperes and can be calibrated at 4 mA for 0% of output and 20 mA for 100% of output or any other values between 0 and 21 mA.

Equipment needed

You will need a standard shop type milliammeter with whatever accuracy is required, capable of measuring 0 to 20 milliamps.

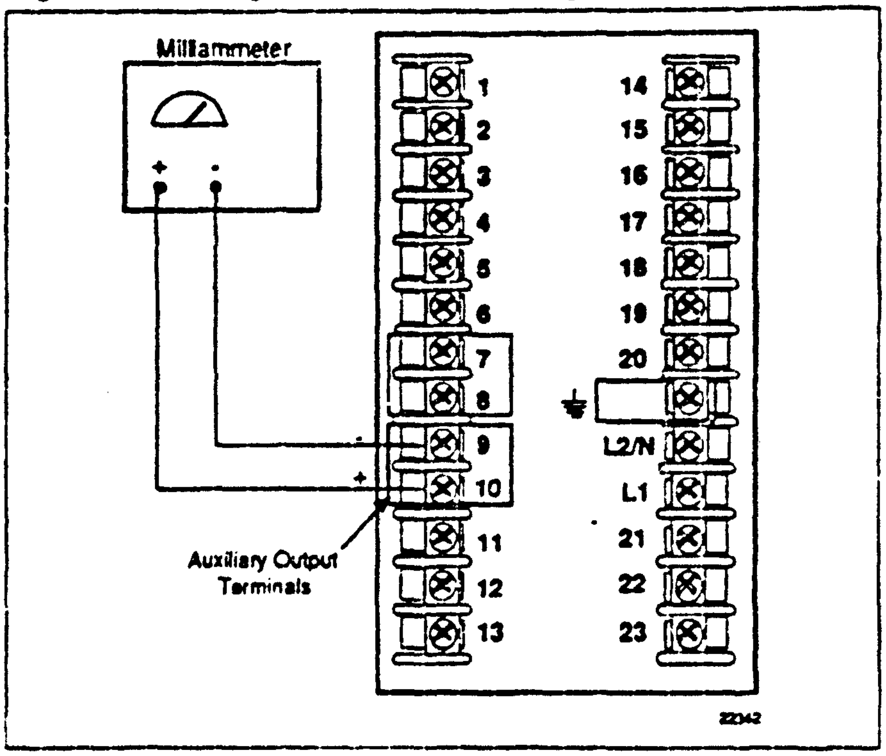
Calibrator connections

Refer to Figure 8-2 and wire the controller according to the procedure given in Table 8-4.

Table 8-4 Set Up Wiring Procedure for Auxiliary Output

Step	Action
1	Apply power and allow the controller to warm up 15 minutes before you calibrate.
2	Tag and disconnect the field wiring, at the rear of the controller, from terminals 10(+) and 9(−). See Figure 8-2. ATTENTION Use terminals 7 and 8 if Auxiliary Output, Remote mode Switching, and Communications Option are all present.
3	Connect a Milliammeter across these terminals.

Figure 8-2 Wiring Connections for Calibrating Auxiliary Output



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Procedure

The procedure for calibrating the Auxiliary Output is listed in Table 8-5. Make sure "LOCKOUT" in the Tuning Set Up group is set to "NONE." See *Section 3 – Configuration.*

Table 8-5 Auxiliary Output Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: AUX OUT
2	Calibrate 0%	FUNC	You will see: Upper Display: a value Lower Display: ZERO VAL
		▲ or ▼	until the desired 0% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 0 mA For 0 to 20 mA Direct Action * 20 mA For 0 to 20 mA Reverse Action 4 mA For 4 to 20 mA Direct Action 20 mA For 4 to 20 mA Reverse Action
3	Calibrate 100%	FUNC	This stores the 0% value and, you will see: Upper Display: a value Lower Display: SPAN VAL
		▲ or ▼	until the desired 100% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 20 mA For 0 to 20 mA Direct Action 0 mA For 0 to 20 mA Reverse Action* 20 mA For 4 to 20 mA Direct Action 4 mA For 4 to 20 mA Reverse Action
4	Exit the Calibration Mode	FUNC	The controller will store the span value.
		LOWR DISP or SET UP	To exit the calibration mode. * When attempting to achieve 0 mA, always adjust the output to about 0.5 mA, and slowly decrease until the output just goes to zero. Further decrementing will not change the output current (since the circuit cannot produce negative current) but will affect the accuracy of the output by creating a dead zone where no current flows.

Section 9 – Troubleshooting / Service

9.1 Overview

Introduction

Instrument performance can be adversely affected by installation and application problems as well as hardware problems. We recommend that you investigate the problems in the following order,

- Installation related problems
- Application related problems
- Hardware and software related problems

and use the information presented in this section to solve them.
If a replacement of any part is required, follow the procedures listed under "Parts Replacement Procedures".

What's in this section?

The following topics are covered in this section.

Continued on next page

Installation related problems

Read the Installation section in this manual to make sure the UDC5000 has been properly installed. The installation section provides information about protection against electrical noise, connecting external equipment to the controller, and shielding and routing external wiring.

ATTENTION System noise induced into the controller will result in diagnostic error messages recurring. If the diagnostic error messages can be cleared, it indicates a "soft" failure and is probably noise related.
If system noise is suspected, completely isolate the controller from all field wiring. Use calibration sources to simulate PV and check all controller functions; i.e. Gain, Rate, Reset, Output, Alarms, etc.

Application related problems

Review the application of the controller; then, if necessary, direct your questions to the local sales office.

Hardware and software related problems

Use the troubleshooting error message prompts and controller failure symptoms to identify typical failures which may occur in the controller. Follow the troubleshooting procedures to correct them.

9.2 Troubleshooting Aids

Overall error messages

An error message can occur
- at power-up
- during continuous background tests while in normal operation
- when the Status Tests are requested

Table 9-1 lists all the error message prompts that you could see, the reason for the failure, and under what test group the prompt could appear.
Refer to Tables 9-3 (Power-up), 9-5 (Status), and 9-6 (Background) for the particular test group indicated.

Table 9-1 Error Message Prompts

Error Message (lower display)	Reason for Failure	Test Group	Refer to Table
BATT LOW	Low Battery Voltage	Background	9-6
CAL TEST	Calibration test failure	Power-up or Status	9-3 9-5
CONF ERR	Low limit greater than high limit for PV, SP, Reset, or Output	Background	9-6
CFGTEST	Configuration data in controller in error	Power-up or Status	9-3 9-5
E E FAIL	Unable to write to non-volatile memory	Background	9-6
FACTEST	Factory Calibration Cyclic Redundancy test	Status	9-5
FAILSF	Controller in Failsafe	Power-up, Background, or Status	9-3 9-6 9-5
INP1FAIL INP2FAIL INP3FAIL	Two consecutive failures of input integration	Background	9-6
INP1 RNG INP2 RNG INP3 RNG	Input Out of Range	Background	9-6
LOOPTEST	DMCS Loopback Test	Status	9-5
NV FAIL	Unable to write to RAM non-volatile memory	Background or Status	9-6 9-5
PV LIMIT	Derived PV Out of Range	Background	9-6
RAM TST	RAM test failed	Power-up or Status	9-3 9-5
RH LO	RH Excessive Temperature depression	Background	9-6
RV LIMIT	Remote Variable Out of Range	Background	9-6
SEG ERR	Start segment > ending segment	Background	9-6
SOOTING	%Carbon falls outside "SOOTING BOUNDARY"	Background	9-6

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9.2 Troubleshooting Aids, Continued

Controller failure symptoms

Other failures may occur that deal with the Power, Output, or Alarms. Refer to the controller failure symptom in Table 9-7 to determine what is wrong and the troubleshooting procedures to use to correct the problem.

Check installation

If a set of symptoms still persists, refer to *Section 2 - Installation* and ensure proper installation and proper use of the controller in the system.

Customer support

If you cannot solve the problem using the troubleshooting procedures listed in this section; get the **model number** and **serial number** and **software** version (see Table 9-2) then:

call Customer Support Phone Number

USA	1-800-423-9883
Canada	1-800-461-0013

If it is determined that a hardware problem exists and the controller is still within the two year warranty, a replacement controller or part will be shipped with instructions for returning the defective unit.

Determining the software version

Table 9-2 lists the procedure for identifying the software version number.

Table 9-2 Procedure for Identifying the Software Version

Step	Operation	Press	Action
1	Select STATUS Set Up Group	SET UP	Until you see: Upper Display READ Lower Display STATUS
2	Read the software version	FUNC	Until you see: Upper Display (blank) ← Software version Number Lower Display VERSION Please give this number to the Customer Support person. It will indicate which version of UDC5000 you have and help them determine a solution to your problem.

9.3 Power-up Tests

What happens at power-up

When the controller is powered-up, three tests are run by the UDC5000 software to ensure memory integrity.
As the tests are run, the displays will appear as shown in Table 9-3.

Table 9-3 Power-up Tests

Lower Display	Upper Display
RAM TEST	PASSED or FAILED
CONFTEST	PASSED or FAILED
CAL TEST	PASSED or FAILED

Test failures

If any of these three tests fail, "FAILSF" will appear momentarily in the upper display, then a display test is run, after which the controller will go into manual mode and you will see:

Upper Display

[ ] ← PV value

Lower Display

[FAILSAFE] (blinking)

Refer to "*Subsection 9.4 -Status Tests*" to determine which tests have failed and how to correct them.

9.4 Status Tests

Introduction

When required, the results of these tests can be checked to determine the reason the controller has gone to "Failsafe".

How to check the status tests

The procedure in Table 9-4 tells you how to display the results of the status tests. Table 9-5 lists the tests, the reason for the failure, and how to correct the problem.

Table 9-4 Procedure for Displaying the Status Tests Results

Step	Operation	Press	Action
1	Select STATUS Set Up Group	SET UP	Until you see: Upper Display READ Lower Display STATUS
2	Read the status tests results	FUNC	Until you see: Upper Display NO or YES — YES indicates a failure Lower Display FAILSF Successive presses of the FUNC key will display the results of the status tests in the following order: NVTEST RAM TEST CFG TEST CAL TEST FACTEST LOOPTEST Identify the problem and correct the failure as shown in Table 9-5.

Continued on next page

9.4 Status Tests, continued

Status Tests Table 9-5 lists the Status tests, the reason for their failure, and how to correct the failure.

Table 9-5 Status Tests

Test (Lower Display)	Definition	Upper Display	Reason for Failure	How to Correct the Failure
FAILSAFE	Failsafe Fault	NO	No Failure	
FAILSF 2 (Loop 2)		YES	Burnout configured for none and input fails. –RAM TEST failed –CONF TEST failed –CAL TEST failed	1. Step through the rest of the STATUS check to identify the particular failure. Press [FUNC] key and then step through all the status prompts a second time to verify if the particular failed code has cleared and shows "Passed". Also see Table 9-6, Background tests.
NVTEST	RAM Test	PASS	NO Failure	
		FAIL	Unable to write to RAM non-volatile memory	1. Step through the rest of the STATUS check to identify the particular failure. Press [FUNC] key.
RAM TEST	RAM test	PASS	No Failure	RAM test passed.
		FAIL	RAM Failure	1. Power cycle to see if the error clears.
CONF TEST	Configuration Checksum	PASS	No Failure	Configuration checksum passed.
		FAIL	Configuration data in the controller is in error.	1. Step through STATUS tests – the controller will recalculate the checksum. 2. Check all configuration prompts for accuracy. See *Section 3 - Configuration.*
CAL TEST	Working Calibration	PASS	No Failure	Working calibration checksum passed.
		FAIL	The working calibration constants in the controller are in error.	1. If the controller has not been field calibrated, see *Section 3 - Configuration* and change the input to a different type. Enter it, loop through the status tests, then return the input type to the original one. 2. If the controller has been field calibrated, recalibrate the controller.

Table 9-5 continued on next page

9.4 Status Tests, Continued

Status Test, continued

Table 9-5 Status Tests, continued

Test (Lower Display)	Definition	Upper Display	Reason for Failure	How to Correct the Failure
FACTTEST	Factory calibration test	PASS	No Failure	Factory calibration cyclic redundancy test passed
		FAIL	Factory set input constants have been changed due to the change in input type.	1. Cycle through Status to clear the error. 2. Check the calibration. Make sure 0 and 100% are correct values. 3. Recalibrate if step 1 is unsatisfactory. Refer to *Section 7- Input Calibration.*
LOCPTEST	DMCS Loopback Test	PASS	No Failure	Loopback Test passed.
		FAIL	Unable to communicate with the controller through DMCS	1. Check to see if the DMCS board • is installed properly • Jumpers are in W1 and W2 Position • transformer cable is connected at J10 2. Check the rear terminal wiring. See *Section 2 - Installation* for terminal designations.

9.5 Background Tests

Introduction

The UDC5000 performs on-going background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed (blinking) in the lower display.

Background Tests

In the case of more than one simultaneous malfunction, only the one with the highest priority will appear in the lower display. Table 9-6 lists these background tests, the reason for their failure, and how to correct the problem.

Table 9-6 Background Tests

Lower Display	Reason for Failure	How to Correct the Problem
BATT LOW	Low Battery Voltage Battery Voltage has fallen below 2.125Vdc.	1. Replace the battery.
EE FAIL	Unable to write to non-volatile memory. Anytime you change a parameter and it is not accepted, you will see EE FAIL.	1. Check the accuracy of the parameter and re-enter. 2. Try to change something in configuration. 3. Run through STATUS tests to re-write to EEPROM.
NVFAIL	Unable to write to RAM non-volatile memory.	1. Check the accuracy of the parameter and re-enter.
FAILSAFE	This error message shows whenever the controller goes into a failsafe mode of operation. This will happen if: • RAM test failed • Configuration test failed • Calibration test failed • Factory Calibration Checksum test failed	1. Run through STATUS check to determine the reason for the failure. 2. Press the [SET UP] key until STATUS appears in the lower display. 3. Press the [FUNC] key to see what tests pass or fail, then run through the STATUS codes a second time to see if the error cleared. 4. Correct according to the recommendations given in Table 9-5.
INP1FAIL INP2FAIL	Two consecutive failures of input integration. i.e., cannot make analog to digital conversion.	1. Make sure the input configuration and wiring is correct. 2. Make sure the cold junction resistor is attached to the rear terminals for thermocouple ranges. 3. Check for gross over-ranging. 4. Replace the cold junction resistor.
INP3FAIL	Two consecutive failures of input 3 integration. i.e., cannot make analog to digital conversion.	1. Make sure the actuation is configured correctly. See Section 3 - Configuration. 2. Make sure the input configuration and wiring is correct. 3. Make sure the 62.5 ohm resistor is attached to the rear terminals for input 3 range of 4–20mA. 4. Check for gross over-ranging.

Table 9-6 continued on next page

Table 9-6 Background Tests, continued

Lower Display	Reason for Failure	How to Correct the Problem
CONF ERR	• PV low limit is > PV high limit • SP low limit is > SP high limit • Reset low limit is > Reset high limit • Output low limit > Output high limit • Conflict between the Remote Mode switches and the input Algorithm selection.	1. Check the configuration for each item and reconfigure if necessary.
INP1 RNG INP2 RNG INP3 RNG	*Input out of range.* The process input is outside the range limits. *Input 3*- The remote input is outside the range limits for 4 to 20 mA or 1 to 5 Volts dc. **ATTENTION** If the range goes outside the range limits, the controller will switch to Manual and the configured Failsafe output value.	1. Make sure the range and actuation are configured properly. 2. Check the input source. 3. If the controller has not been field calibrated, see *Section 3 - Configuration* and change the input to a different type. Enter it, loop through the status tests, then return the input type to the original one. 4. If the controller has been field calibrated, recalibrate the controller.
PV LIMIT	A. PV out of range. PV = INP1 + INP1 BIAS B. Second input algorithm selection (for example: Carbon Potential) does not permit Remote Switching parameter selection of PVIN2 or PVIN3.	A1. Make sure the input signal is correct. A2. Make sure the Bias setting is correct A3. Recheck the calibration. Use Bias of 0.0 B1. Reconfigure the second Input algorithm.
RHLO	RH Excessive Temperature Depression when calculated %RH is less than 0%.	1. Make sure the range and actuation are configured properly. 2. Check the input source. 3. If the controller has not been field calibrated, see *Section 3 - Configuration* and change the input to a different type. Enter it, loop through the status tests, then return the input type to the original one. 4. If the controller has been field calibrated, recalibrate the controller.
RV LIMIT	The result of the formula shown below is beyond the range of the remote variable. RV = (INP2 X RATIO) + BIAS	1. Make sure the input signal is correct. 2. Make sure the Ratio and Bias settings are correct. 3. Recheck the calibration. Use a Ratio of 1.0 and a Bias of 0.0.

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Table 9-6 Background Tests, continued

Lower Display	Reason for Failure	How to Correct the Problem
SEG ERR	The start segment number is greater than the ending segment number.	1. Reconfigure - make start segment number less than end segment number..
SOOTING	Percent Carbon falls outside "SOOTING BOUNDRY".	1. Make sure the range and actuation are configured properly. 2. Check the input source. 3. If the controller has not been field calibrated, see *Section 3 - Configuration* and change the input to a different type. Enter it, loop through the status tests, then return the input type to the original one. 4. If the controller has been field calibrated, recalibrate the controller.

9.6 Controller Failure Symptoms

Introduction

In addition to the error message prompts, there are failure symptoms that can be identified by noting how the controller displays and indicators are reacting.

Symptoms

Compare your symptoms with those shown in Table 9-7 and refer to the troubleshooting procedure indicated to correct the problem.

Table 9-7 Controller Failure Symptoms

Upper Display	Lower Display	Indicators	Controller Output	Probable Cause	Trouble-shooting Procedure
Blank	Blank	Off	None	Power Failure	1
OK	Displayed Output disagrees with Controller Output	OK	Controller Output disagrees with Displayed Output	Current Proportional Output	2
OK		OK		Time (Relay) Proportional Output	3
OK		OK		Position Proportional Output	4
OK		OK		Current/Time Proportional Output	5
OK	OK	OK	External Alarm function does not operate properly	Malfunction in alarm output	6
Display does not function when a key is pressed				Keyboard Malfunction	7
Controller fails to go into "Slave" operation during communications				Communications Failure	8

Other symptoms

If a set of symptoms or prompts other than the one you started with appears while troubleshooting, re-evaluate the symptoms. This may lead to a different troubleshooting procedure.

If the symptom still persists, refer to the installation section in this manual to ensure proper installation and proper use of the controller in your system.

9.7 Troubleshooting Procedures

Introduction

The troubleshooting procedures are listed in numerical order as they appear in Table 9-7. Each procedure lists what to do if you have that particular failure and how to do it or where to find the data needed to accomplish the task.

Equipment needed

You will need the following equipment in order to troubleshoot the symptoms listed in the tables that follow:

- DC Milliammeter – mAdc
- Calibration sources – T/c, mV, Volt, etc.
- Voltmeter

Procedure #1

Table 9-8 explains how to troubleshoot power failure symptoms.

Table 9-8 Troubleshooting Power Failure Symptoms

Step	What to do	How to do it
1	Check the AC line voltage.	Use a Voltmeter to measure the AC voltage across terminals L1 and L2 on the rear terminal panel of the controller. Check the earth ground connection.
2	Make sure the chassis plugs into the rear of the case properly.	Withdraw the chassis and visually inspect the main printed wiring board and the inside of the case.
3	Check the Voltage selection.	See if the Power Select Jumper on the main printed wiring board is in the proper position for the Voltage being used. Refer to Section 2 - *Installation*.
4	Check the system for Brown-outs, heavy load switching, etc.; and conformance to installation instructions.	Refer to *Section 2 - Installation*.

Continued on next page

Procedure #2

Table 9-9 explains how to troubleshoot Current Proportional Output failure symptoms.

Table 9-9 Troubleshooting Current Proportional Output Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Current output.	Make Set Up group prompt "OUT ALG". Function prompt "OUT ALG" – selection "CURRENT" Refer to *Section 3 - Configuration.*
2	Check the field wiring.	Output impedance must be less than or equal to 1000 Ohms.
3	Make sure all the configurable tuning constants, limits, and configuration data stored in the controller are correct. Reconfigure, if necessary.	Refer to *Section 3 - Configuration* to check all this data and how to reconfigure.
4	Check the output.	Press the [LOWR DISP] key until you see OUT in the Lower Display. Change the output from 0 to 100% (4-20 mA). Use a DC milliammeter at the rear terminals to verify the output. 4–20mA output corresponds to an output of 0 to 100%.
5	Recalibrate the Current Proportional Output.	Refer to *Section 8 - Output Calibration* for details

Continued on next page

Procedure #3

Table 9-10 explains how to troubleshoot Time Proportional Relay Output(s) failure.

Table 9-10 Troubleshooting Time Proportional Relay Output(s) Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Time Proportional or Time Proportional Duplex output.	Make Set Up group prompt "OUT ALG". Function prompt "OUT ALG" = selection is "TIME" or "TIME D whichever is required. Refer to *Section 3 - Configuration.*
2	Check the field wiring.	See *Section 2 - Installation* for wiring diagrams.
3	Make sure all the configurable tuning constants, limits, and configuration data stored in the controller are correct. Reconfigure, if necessary.	Refer to *Section 3- Configuration* to check all this data and how to reconfigure.
4	Check that the applicable output relay actuates properly per the controller output value.	• Vary the setpoint around the PV. Listen for the click of the relay as the setpoint moves in either direction. Observe OUT1 or 2 light on the operator interface.
5	Check the Output (control) relay contact selection.	• Refer to *Section 2 - Installation* for Relay contact information.

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Procedure #4

Table 9-11 explains how to troubleshoot Time/Current or Current/Time Proportional Relay Output(s) failure.

Table 9-11 Troubleshooting Time/Current or Current/Time Proportional Relay Output(s) Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Time/Current or Current/Time Proportional output.	Make Set Up group prompt "OUT ALG". Function prompt "OUT ALG" = selection is "CUR TI" or "TI CUR whichever is required. Refer to *Section 3 - Configuration.*
2	Make sure all the configurable tuning constants, limits, and configuration data stored in the controller are correct. Reconfigure, if necessary.	Refer to *Section 3- Configuration* to check all this data and how to reconfigure.
3	Check that the applicable output relay actuates properly per the controller output value.	• Vary the setpoint around the PV. Listen for the click of the relay as the setpoint moves in either direction. Observe OUT1 or 2 light on the operator interface.
4	Check the Output (control) relay contact selection.	• Refer to *Section 2 - Installation* for Relay contact information.
5	Check the Current Proportional Output.	• Put the controller into manual mode and vary the output from 0 to 100% (4–20mA). Use a DC milliammeter at the rear terminals to verify the output.
6	Recalibrate the controller.	Refer to *Section 8 - Output Calibration* for details.

Continued on next page

Procedure #5

Table 9-12 explains how to troubleshoot Position Proportional Relay Output(s) failure.

Table 9-12 Troubleshooting Time/Current or Current/Time Proportional Relay Output(s) Failure

Step	What to do	How to do it
1	Make sure that the Position Proportional printed wiring board is installed properly.	• Pull the chassis from the case and visually inspect the board. See *Section 10 - Parts List* for location.
2	Make sure the controller is configured for Position Proportional output.	Make Set Up group prompt "OUT ALG". Function prompt "OUT ALG" = selection "POSITN" Refer to *Section 3 - Configuration.*
3	Check the field wiring.	See *Section 2 - Installation* for wiring diagrams.
4	Check the Output.	• Put the controller into manual mode and vary the output from 0 to 100% .
5	Check whether the motor drives in both directions. If the motor drives in one direction, check the slidewire. If the motor does not drive in either direction, check the motor.	•Refer to the Position Proportional Calibration procedure in *Section 8 - Output Calibration* for motor slidewire calibration. •Refer to the motor instructions.
6	Check the Voltage output to the slidewire.	• Should equal 1.34 to 1.04 Volts. See *Section 2 - Installation* for terminal designations. The feedback slidewire output voltage must vary with the valve position. If not, recalibrate using "AUTO" mode and check again.
7	Make sure that the output relays are actuating properly. If they are not, check the field wiring then go to step 6. If they are, go to step 8.	• Place the controller into manual mode. Vary the output above and below the present value. Listen for the click of the relays. One relay should click when the output is moved higher, and the other should click when the output is moved lower than the present setting. Observe OUT 1 and 2 on the operator interface.
8	Check the Output (control) relay contact selection.	• Refer to *Section 2 - installation* for Relay contact information.
9	Replace the Position Proportional printed wiring board	• Refer to the "Replacement Procedures" in this section.
10	Recalibrate the controller.	Refer to *Section 8 - Output Calibration* for details.

Continued on next page

Procedure #6

Table 9-13 explains how to troubleshoot Alarm Relay Output(s) failure.

Table 9-13 Troubleshooting Alarm Relay Output(s) Failure

Step	What to do	How to do it
1	Check the alarm configuration data. If it is correct, check the field wiring.	Reconfigure if necessary. Refer to *Section 3 - Configuration* for details.
2	Check that the applicable alarm relay actuates properly. It depends on what you have set at "ALARMS" group prompt "AxSxTYPE". If it does, check the field wiring.	If the alarm type is set for PV, place the controller in manual mode. Vary the input to raise and lower the PV around the setpoint. Note that the proper annunciators flash. If the alarm is set for OUTPUT, put the controller into manual mode. Raise or lower the output above or below the value you have set as the alarm setpoint. Note that the proper annunciators flash. Check for proper continuity when the alarm actuates.
3	Check the Output (alarm) relay contact selection.	• Refer to *Section 2 - Installation* for Alarm relay contact information.

Continued on next page

Procedure #7

Table 9-14 explains how to troubleshoot a Keyboard failure.

Table 9-14 Troubleshooting a Keyboard Failure

Step	What to do	How to do it
1	Make sure the keyboard is connected properly to the Display board.	Withdraw the chassis from the case and visually inspect the connection.
2	Controller Keyboard may be "LOCKED OUT" via the security code.	Use your 4 digit security code number to change the lockout level. Refer to *Section 3 – Configuration*. ATTENTION Using "1000" as a security code number will override the 4-digit code previously entered.
3	Run the keyboard test.	Press the SET UP key and hold in, then press the FUNC key at the same time. The controller will run a display test. Then you will see: Upper Display KEYS Lower Display TRY ALL Press each key. If it works, the key name will appear in the lower display.
4	Replace the keyboard if any keys are shorted out.	Refer to *"Parts Replacement Procedures"* in this section.

Continued on next page

Procedure #8

Table 9-15 explains how to troubleshoot a Communications failure.

Table 9-15 Troubleshooting a Communications Failure

Step	What to do	How to do it
1	Check the field wiring and termination resistor.	Depending on the protocol used, refer to the proper Communications Manual Installation Section.
2	Make sure the Communications Printed Wiring Board is installed properly in the controller.	Withdraw the chassis from the case and inspect the board. See the exploded view (Figure 10-1) for location of the board. Return the chassis to the case.
3	Determine if the Communications board is faulty by running a LOCAL LOOPBACK TEST. If the test fails, replace the board.	Run the Local Loopback Test. Press [SET UP] until you see: Upper Display: SET UP Lower Display: COM Press [FUNC] until you see: Upper Display: DISABL Lower Display: LOOPBACK Press ▲ or ▼, you will see: Upper Display: Enable Lower Display: LOOPBACK The test will run until the operator disables it here.

9.8 Parts Replacement Procedures

Introduction

These procedures tell you how to access and replace the following printed wiring boards in your controller.

- Keyboard and/or Display Board
- Parts on the Controller Board
  - Battery
  - PROM
  - Control Relays
- Auxiliary Output/Remote Mode Switching Option Board
- Second Input Board
- Communications Option Board
- Controller Board
- Transmitter Power Board

Figure 9-1 shows you how to remove the chassis from the case.

Figure 9-2 identifies all the Printed Wiring Boards and parts necessary to facilitate removing and replacing the Parts listed above.

Equipment needed

To accomplish the procedures that follow, you will need the following equipment:

- Phillips Head Screwdriver
- Flat Bladed Screwdriver
- Small Pliers

Continued on next page

9.8 Parts Replacement Procedures, Continued

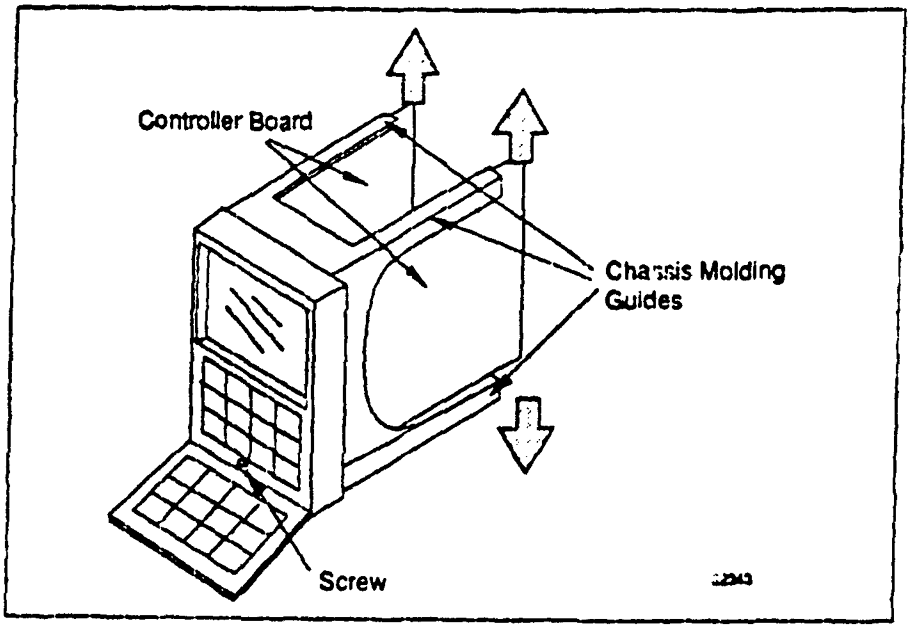
How to remove the chassis and controller board

Refer to Figure 9-1 for steps and follow the procedure listed in Table 9-16.

Table 9-16 How to Remove the Chassis and Controller Board

Step	Action
1	Pull down the front door and loosen the screw.
2	Grasp the bezel and pull the chassis out of the case.
3	Spread the top and bottom chassis moulding guide railings to dislodge the controller board notches from their locks.
4.	Pull on the controller board and slide it out. The board will unplug from the display board.

Figure 9-1 Chassis and Controller Board Removal



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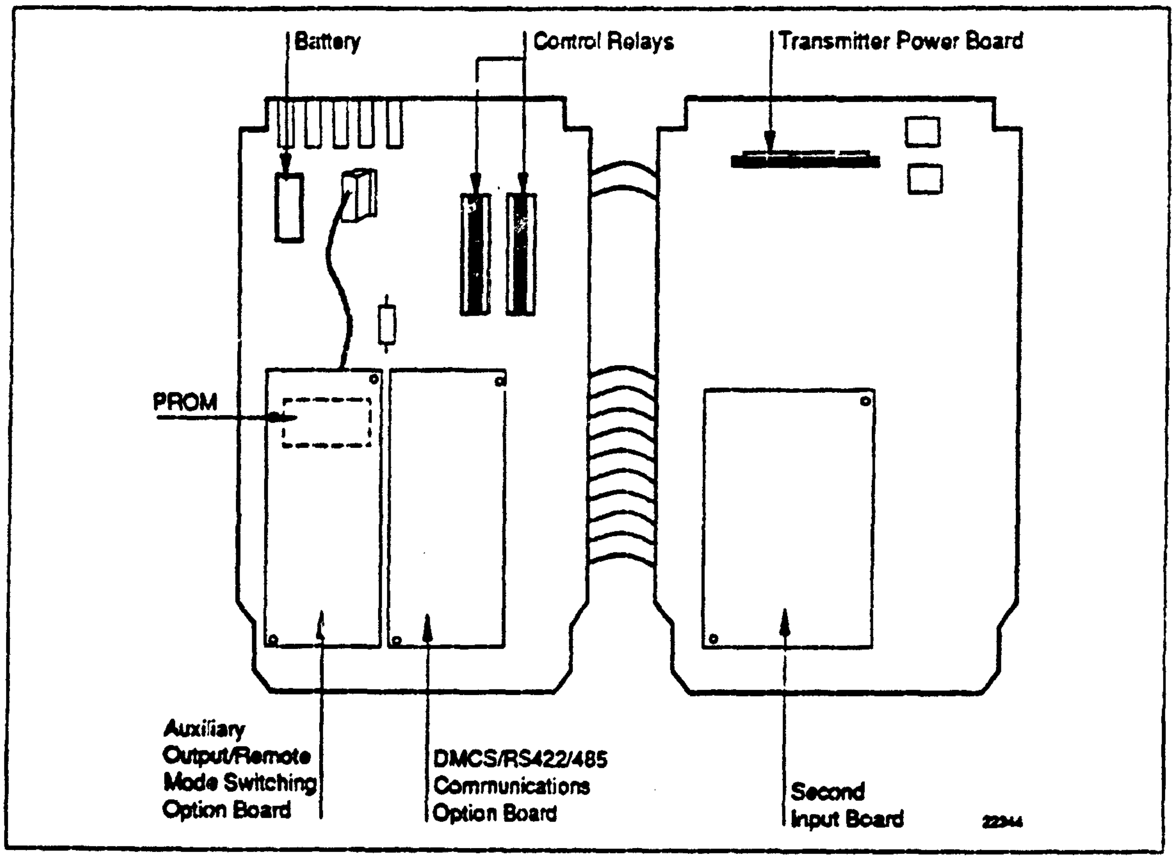
Parts and printed wiring board identification

Figure 9-2 identifies all the Parts and Printed Wiring boards located on the Controller Printed Wiring Board.

Figure 9-2 Controller Parts and Printed Wiring Boards Identification



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9.8 Parts Replacement Procedures, Continued

How to replace the Battery, PROM, or Control Relays

Refer to Figure 9-2 for parts location and follow the procedures in Table 9-17 to replace the Battery, PROM, or Control Relays.

Table 9-17 Battery, PROM, or Control Relay Replacement Procedures

Step	Action
1	Remove the chassis from the case as shown in Figure 9-1.
2	Remove the controller board from the chassis as shown in Figure 9-1.
3	Disassemble the controller board from the thermal barrier and lay the board out on a static free flat surface.
BATTERY	
1	Unsolder the old battery and solder the new battery into place. ATTENTION If you have Setpoint Programming option, reconfigure the parameters (See Section 6 - Setpoint Ramp/Soak Programming).
PROM	
1	Remove the Auxiliary Output/Remote mode switching option board. Refer to Figure 9-2 for location and Table 9-18 for procedure.
2	Replace the PROM. Make sure the PROM is oriented properly.
3	Replace the Auxiliary Output/Remote Mode Switching option board.
CONTROL RELAYS	
1	Push the clip off the control relay and pull the relay out of the socket.
2	Install the new relay and replace the clip.

Continued on next page

How to replace the auxiliary output/remote mode switching option board

Refer to Figure 9-2 for parts location and follow the procedures in Table 9-18 to replace the Auxiliary Output/Remote Mode Switching Option board.

Table 9-18 Auxiliary Output/Remote Mode Switching Option board Replacement Procedures

Step	Action
1	Remove the cable if present at J12 on the option board.
2	Remove the two screws on the other side of the controller board that hold the option board in place and pull the board up.
3	Make sure jumpers W1, W2, W3, W4, and W5 are in the same position as on the old board. Install W3, W4, W5 for *Remote Mode Switching* or *Auxiliary Output and Remote mode Switching* Install W1, W2 for *Auxiliary Output* or *Auxiliary Output and Remote Mode Switching* ATTENTION **DO NOT install for Auxiliary Output, Remote Mode Switching, and Communications (Use the Cable to J12)** Install W3 and RMS cable for *Communications* and *Remote Mode Switching.*
4	Install the new option board using the same screws.
5	Reattach connector J12 if present.

Continued on next page

How to replace the communications option board.

Refer to Figure 9-2 for parts location and follow the procedures in Table 9-19 to replace the Communications Option board.

Table 9-19 Communications Option board Replacement Procedures

Step	Action
1	Remove the two screws on the other side of the controller board that hold the Communications Option board in place and pull the board up.
2	Position jumpers W1 and W2 in the same position as the old board: Install W1 and W2 for *Communication* and *Auxiliary Output Option* or *NO option*.
3	Instal the new Communications board using the same screws.

Continued on next page

How to replace the second Input board

Refer to Figure 9-2 for parts location and follow the procedures in Table 9-20 to replace the Second Input board.

Table 9-20 Second Input board Replacement Procedures

Step	Action
1	Remove the two screws on the other side of the controller board that hold the second input board in place, and pull the board up.
2	Position W1/W2 jumper the same as on the old board: W2 position for *Carbon Potential* W1 position for *all other selections*
3	Install the new second input board using the same screws.
4	Factory calibration constants will be approximate. Check the calibration. If incorrect, recalibrate.

Continued on next page

How to replace the controller printed wiring board

To replace the Controller printed wiring board follow the procedure listed in Table 9-21. Figure 9-3 shows all the Jumpers and their locations.

Table 9-21 Controller Board Replacement Procedure

Step	Action
1	Remove the chassis from the case as shown in Figure 9-1.
2	Remove the controller board from the chassis as shown in Figure 9-1.
3	Disassemble the controller board from the thermal barrier and lay the board out on a static free flat surface.
4	Remove all the option boards as shown in Table 9-18, 9-19, and 9-20. Make sure all the jumpers are in the same position as on the original controller board. Refer to Figure 9-3 for jumper locations.
5	Install the option boards removed from the old board onto the new controller board.
6	Reassemble the heat shield to the controller board.
7	Slide the controller board into the chassis guide molding and push into place.
8	Return the chassis to the case and tighten the screw.

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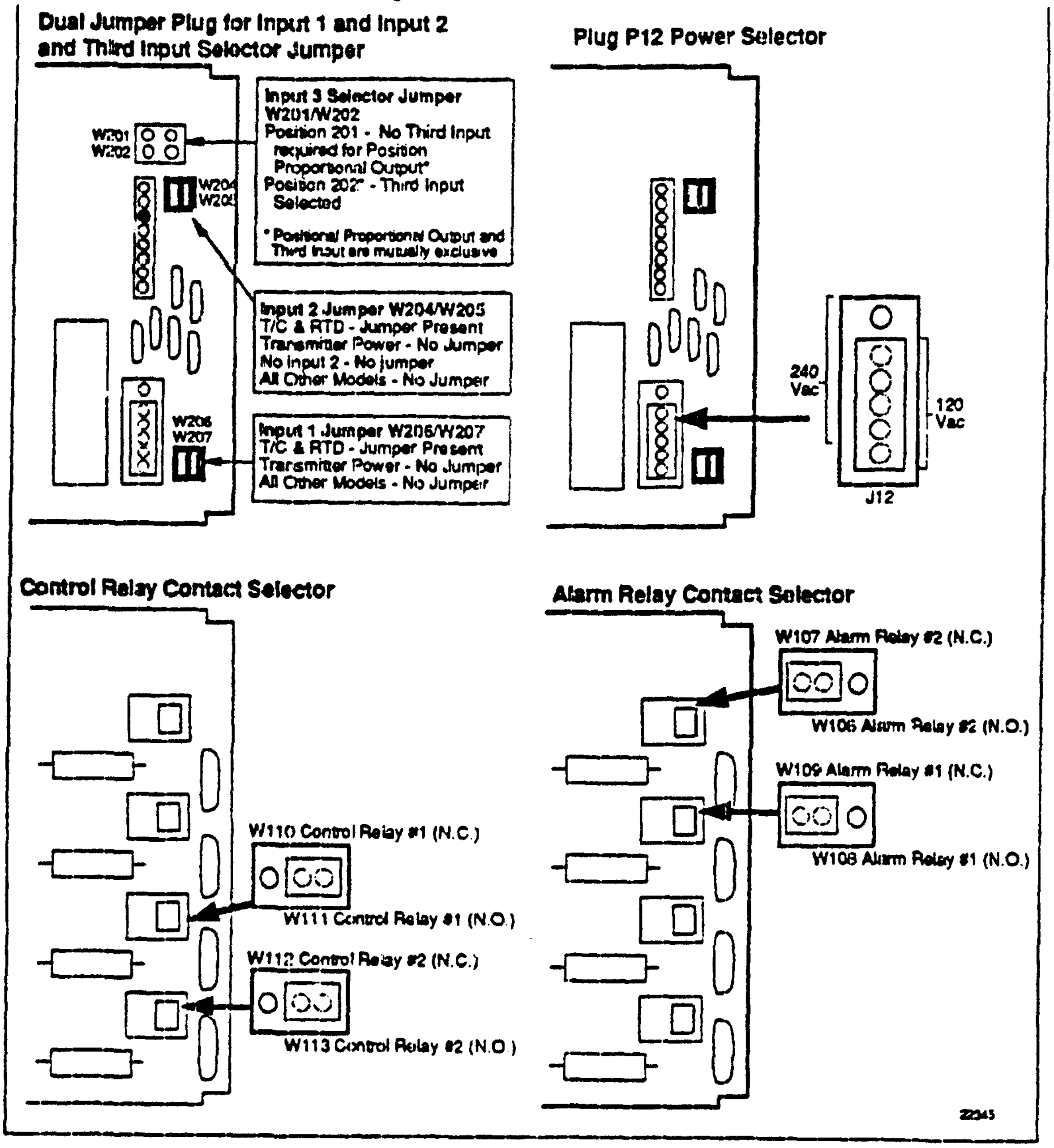
9.8 Parts Replacement Procedures, Continued

How to replace the controller printed wiring board

Figure 9-3 shows the location of the Jumper locations on the controller board.

Figure 9-3 Controller Board Jumper Locations



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How to replace the transmitter power printed wiring board

To replace the Transmitter Power printed wiring board, refer to Figure 9-4 for Jumper locations and follow the procedure listed in Table 9-22.

Table 9-22 Transmitter Printed Wiring Board Replacement Procedure

Step	Action
1	Remove the chassis from the case as shown in Figure 9-1.
2	Place the chassis on a clean, static-free work surface, right side down. The Transmitter power board plugs into the controller board at the rear.
3	Configure the new Transmitter Power board to provide power to the particular input circuit that you intend to use. Install the cowbell jumpers across the appropriate pins on the new power bower board to match the jumpers on the old board. Refer to Figure 9-6 for location of jumpers. **TRANSMITTER POWER** — **JUMPER POSITIONS** Input 1 only — W3 and W4 Input 2 or Input 3 — W1 and W2 Input 1, 2, and 3 — W1, W2, W3, W4 Disable Inputs — Remove all jumpers
4	Remove the old transmitter power board from connector J6 at the rear of the right-hand portion of the controller board and insert the new one. Make sure the new board snaps into place.
5	Locate and check the two dual jumper positions identified as W206/W207 and W204/W205, at the rear of the right-hand portion of the controller board. The jumpers are correctly positioned when the white lines are vertical. See Figure 9-6 for proper position.
6	Locate and check the jumper for Input 3 selection identified as W201/W202. Refer to Figure 9-4 for proper position.
7	Reinstall the chassis in the case and turn the screw on the front of the controller clockwise until the chassis is secured in place.
8	Check the field wiring. a. Check the connections of the 2-wire transmitter(s) to the input terminals at the rear of the case. External wiring diagrams for the various types of outputs are contained in the installation section. b. Apply power to the controller.

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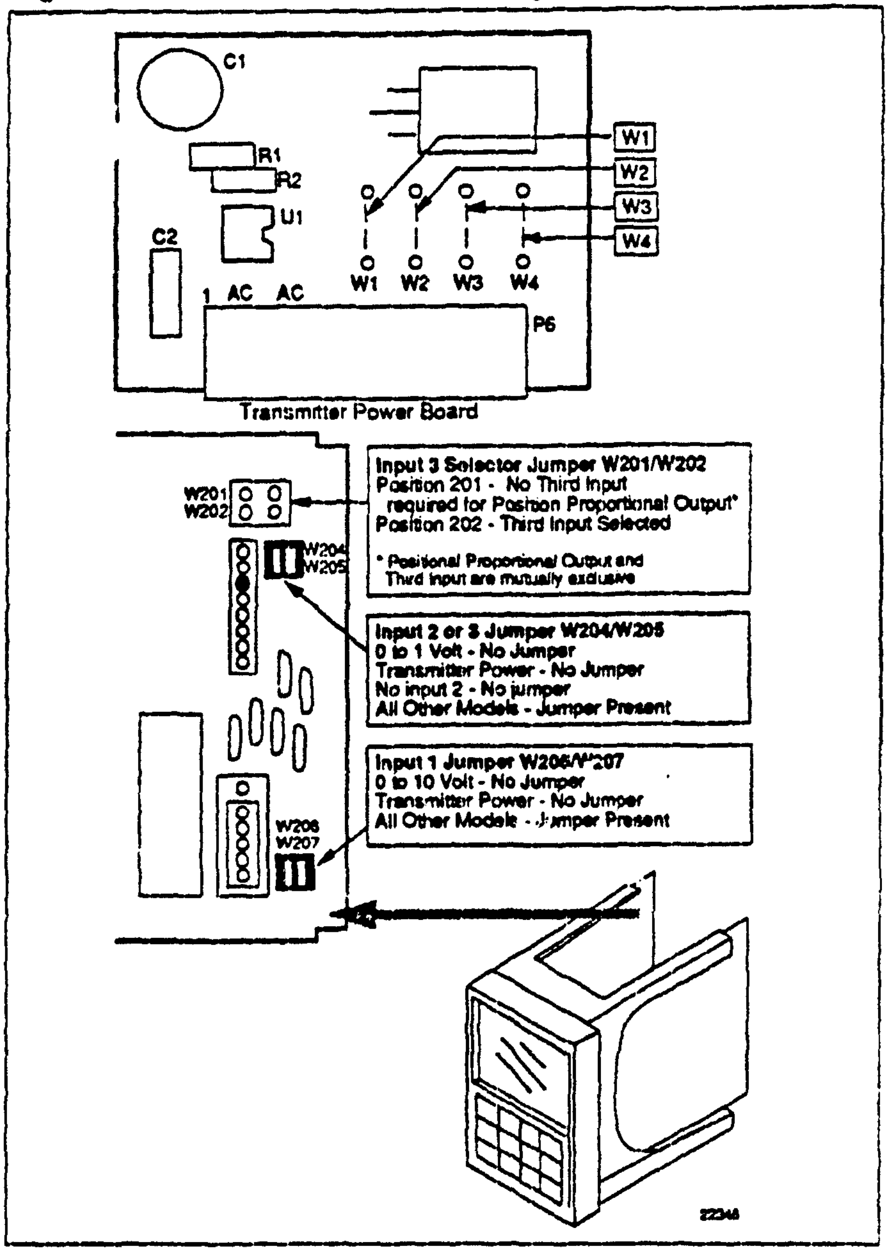
How to replace the transmitter power printed wiring board

Figure 9-4 Transmitter Power Board Jumper Locations



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How to replace the keyboard or display printed wiring board

To replace the Keyboard or Display printed wiring board, refer to Figure 9-7 and follow the procedure listed in Table 9-23.

Table 9-23 Keyboard or Display Printed Wiring Board Replacement Procedure

Step	Action
1	Remove the chassis from the case as shown in Figure 9-1.
2	Remove the controller board from the chassis molding as shown in Figure 9-1.
KEYBOARD	
1	Remove the door. Pull on one side of the bezel and slide the nub on the door up, out of place.
2	Disconnect the cable attached to the rear of the display board. Refer to Figure 9-5.
3	Spread the side of the bezel and insert a small screwdriver under a lower corner of the keyboard and pry out from the bezel. Refer to Figure 9-5.
4	Insert the new keyboard, sliding the cable through the opening in the display board and push the keyboard into place.
5	Make the connection at the rear of the display board.
DISPLAY BOARD	
1	Remove the keyboard as shown above.
2	Grasp the bezel with each thumb on the inside. Pull on each side of the bezel and push the display board out with your fingers from behind. Refer to Figure 9-5.
3	Position the new display board and snap into place.
4	Replace the keyboard as shown.

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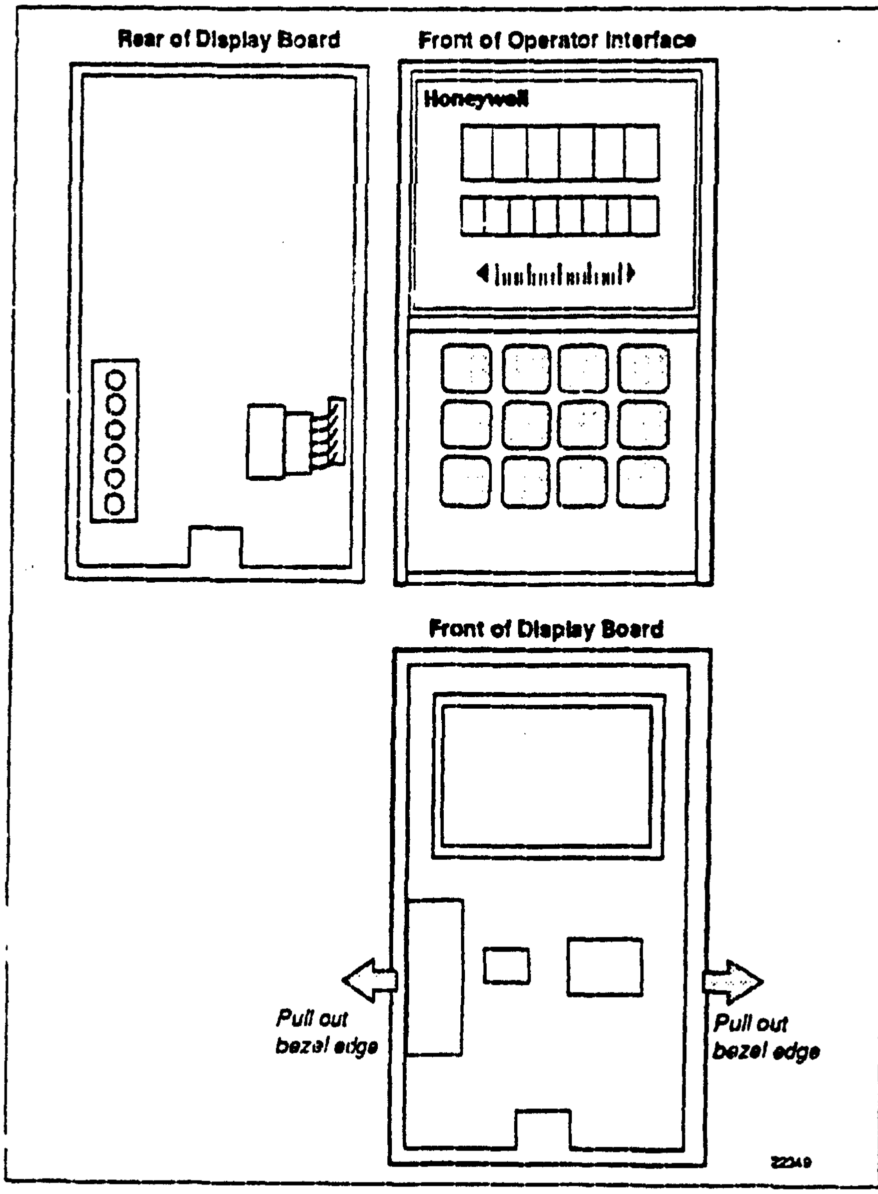
How to replace the keyboard or display printed wiring board, continued

Figure 9-5 Keyboard or Display Printed Wiring Board Replacement



9.9 Maintenance

Cleaning

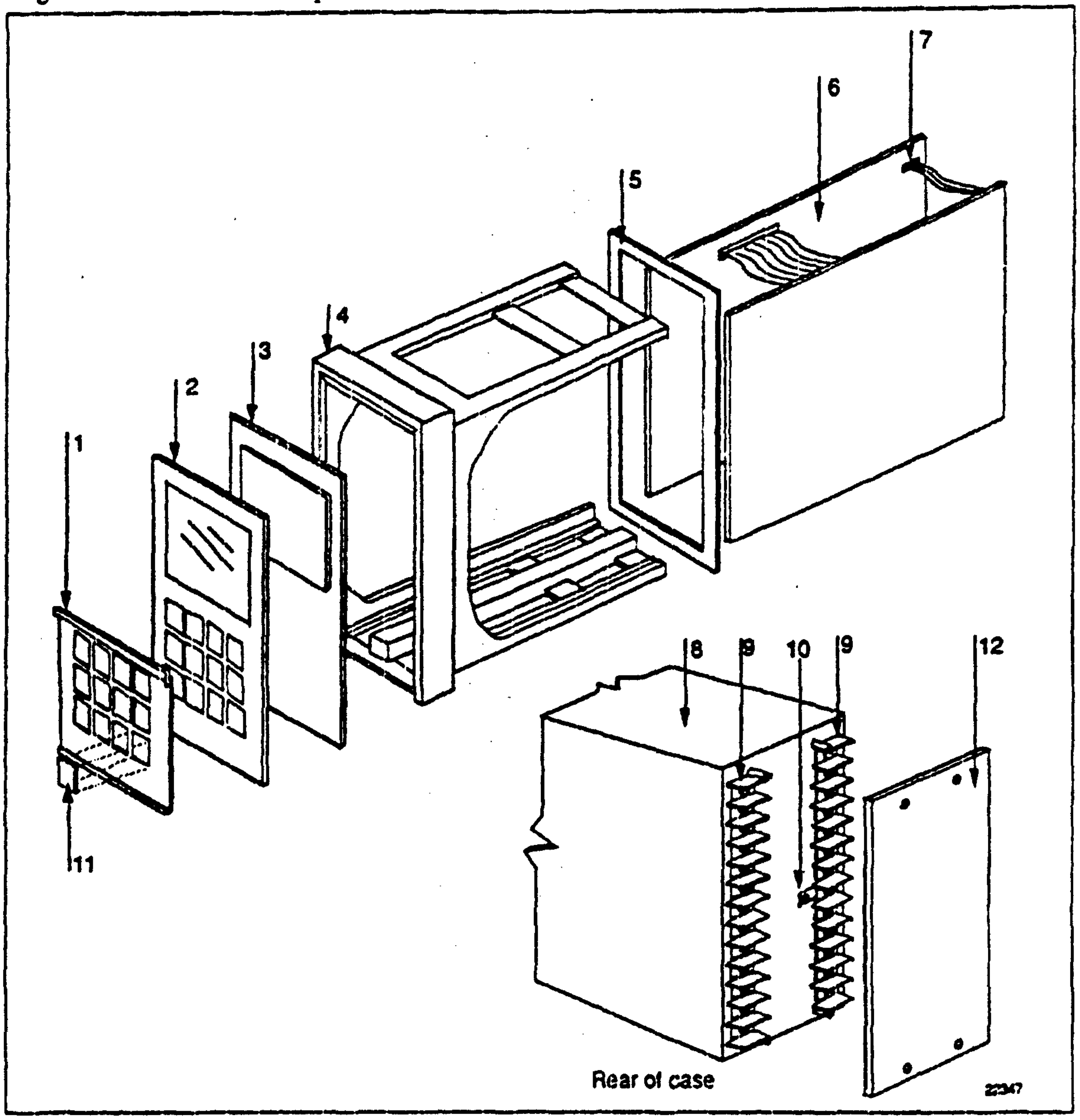
If you find it necessary to clean the elastomer bezel, use an alcohol solution of 50% or less or mild soapy water.

10.1 Exploded View

Introduction

Figure 10-1 is an exploded view of the UDC5000 Controller. Each part is labeled with a key number. The part numbers are listed by key number in Table 10-1. There is a list of parts not shown in Table 10-2.

Figure 10-1 UDC5000 Exploded View



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10.1 Exploded View, Continued

Parts Identification

Table 10-1 lists the part numbers for the key numbers shown in the exploded view.

Table 10-1 Parts Identification

Key Number	Part Number	Description	Quantity
1	K30756035-501* K30756035-502*	Door (blue color) Door (gray color)	1
2	30755404-501 30755404-502	Keyboard Assembly - blue Keyboard Assembly - gray	1
3	30755399-501	Display Printed Wiring Board	1
4	K30756035-501* K30756035-502*	Chassis Molding - blue Chassis Molding - gray	1
5	30755858-501	Rubber Gasket	1
6	See Figure 10-2	Controller Printed Wiring Board	1
7	K30756035-501* K30756035-502*	Thermal Barrier - blue Thermal Barrier - gray	1
8	K30756035-501* K30756035-502*	Case - blue Case - gray	1
9	30754499-003	Rear Connector (terminal) Kit (1 per kit)	2
10	K30756035-501* K30756035-502*	Ground Strap - blue Ground Strap - gray	1
11	K30756035-501* K30756035-502*	Button Molding Kit (12 buttons per kit) - blue Button Molding Kit (12 buttons per kit) - gray	1
12	30754494-001	Rear Cover Kit	1

* Kit 30756035-501 also contains mounting hardware not shown.

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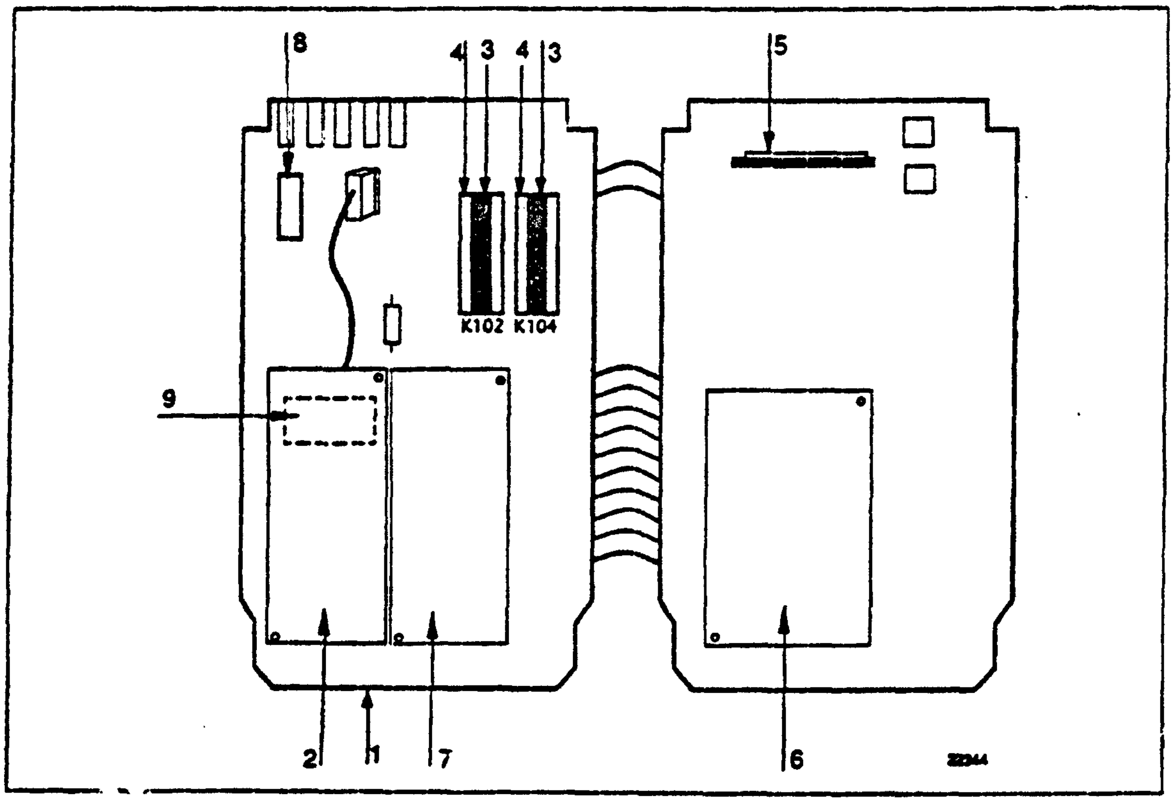
10.2 Controller Board View, Continued

Introduction

Figure 10-2 is a view of the Controller Printed Wiring Board. Each part is labeled with a key number. The part numbers are listed by key number in Table 10-2. There is a list of parts not shown in Table 10-3.

Figure 10-2 Controller Wiring Board Parts



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10.2 Controller Printed Wiring Board View, Continued

Parts Identification

Table 10-2 lists the part numbers for the key numbers shown in Figure 10-2.

Table 10-2 Controller Printed Wiring Board Parts

Key Number	Part Number	Description	Quantity
1		Controller Printed Wiring Board	1
	30755393-502	Current Output	
	30755393-503	Time, Current Time Duplex, Position or Universal Outputs	
2	30755402-501	Auxiliary Output / Remote Mode Switch Printed Wiring Board	1
3	K30754499-501	Output Relay Hold down (2 per kit)	2
4	K30754499-501	Output Relay (2 per kit)	2
5	30754385-501	Transmitter Power PWB	1
6	30755408-501	Second Input Printed Wiring Board	1
7	30755408-501	DMCS Communications Printed Wiring Board	1
	30755865-002	RS422/485 Communications Printed Wiring Board	
8	30750596-001	Battery	1
9		**PROM - 28 pins Memory Upgrade Kits (all include Communications)**	1
	30756133-501	Autotune + Input 3	
	30756134-501	Autotune + Input 3 + Setpoint Program/Math	
	30756135-501	2 Loops PID + Autotune + Input 3	
	30756136-501	2 Loops + Autotune + Input 3 + Setpoint Program/Math	
		PROM - 32 pins Memory Upgrade Kits (all include Communications)	
	30756550-501	Autotune + Input 3	
	30756551-501	Autotune + Input 3 + Setpoint Program/Math	
	30756552-501	2 Loops PID + Autotune + Input 3	
	30756553-501	2 Loops + Autotune + Input 3 + Setpoint Program/Math	

Continued on next page

10.3 Parts not Shown, Continued

Parts not shown

Table 10-3 lists the part numbers of the parts not show in Figures 10-1 and 10-2.

Table 10-3 Parts Not Shown

Part Number	Description	Quantity
30754466-501	4–20 mA Resistor Assembly (ohms)	1
30754465-501	0–10 Volt Input Resistor Network	1
30757088-501	Cold Junction Resistor Kit	1*
30732481-002	Single Metal Oxide Resistor	1
30754499-004	Fuse Kit	1
30754471 -001	Universal Input Kit	1
30755946-501	Third Input 1 to 5 Volt dc Interface Board	1
30756013-001	Single Solid State Relay Assembly - 2 Amp	1
30756016-001	Dual Solid State Relay Assembly - 2 Amps	2 relays
30756018-002	Single Solid State Relay Assembly - 10 Amp	1
30752640-001	Adapter Plate	1
30755050-001	Mounting Kit (2 brackets)	1
30754499-001	Jumper Kit	1
30756214-501	Open Collector Adapter	1

Appendix A – Manual Tuning

A.1 Overview

Introduction

When you tune a controller, there are some things to consider:

• Process Characteristics - Gain, Time Constants, etc.

• Desired response - Minimal overshoot

Basically, controller tuning consists of determining the appropriate values for the Gain (PB), Rate (Derivative), and Reset (Integral) time tuning parameters (control constants) that will give the control you want. Depending on the characteristics of the deviation of the process variable from the setpoint, the tuning parameters interact to alter the controller's output and produce changes in the value of the process variable.

Since each parameter responds to a specific characteristic of the deviation, you may not need a combination of all three. It depends on the process characteristics and the desired control response.

Tuning technique

You can estimate a starting point and the tuning parameters required to give the desired controller response and with some experience become proficient with this method.

An alternate approach is to rely on a tuning technique. In practice, tuning techniques usually do not give exactly the type of response desired; thus, some final adjustments to the tuning parameters must be made.

However, you should at least obtain a reasonable starting point from which the desired response characteristics can be obtained.

Controller tuning procedures

There are three procedures for tuning the controller:

- Time, Position, or Current Proportional simplex control,
- Duplex Time or Current Proportional control,
- Two sets of tuning constants for single output operation.

The suggested procedures describe how to establish and store values of Gain(PB), Rate, and Reset time constants for your process. You must know the type of control and algorithm your controller has.

Tuning aids

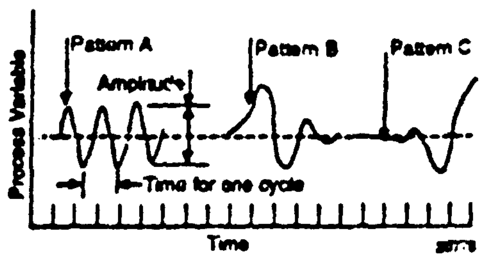
A graphic recorder (such as Honeywell model DPR, DR4500, or VP131) connected to the process variable will make it easier to determine when the oscillations are constant and also the time for one oscillation. If a recorder is not available, you can use a stop watch to time the oscillation of the process variable displayed on the controller.

A.2 Time, Position, or Current Proportional (Simplex) Control

Procedure

The procedure listed in Table A-1 gives you the steps for manually tuning a controller with Time, Position, or Current proportional simplex control.

Table A-1 Manual Tuning Procedure for Simplex Control

Step	Action
1	In Manual Mode, adjust the output to bring the PV (Process Variable) near the desired value.
2	Set the Rate time to 0 minutes and set the Reset time to the maximum value (50.00 minutes) or set repeats/min to the minimum value to minimize reset action If applicable, set the CYCLE TIME to 4 seconds and DEADBAND to 0.5.
3	Increase GAIN (decrease PB) significantly. Try a factor of 10
4	Adjust the local setpoint to equal PV and switch to Automatic control mode.
5	Increase the setpoint by 5 or 10% and observe the process variable response.
6	If the PV oscillates, continue to step 7. If it does not oscillate, return to the original setpoint and increase GAIN (decrease PB) again by a factor of 2, and repeat step 5.
7	Compare the oscillations with the figure below:  • If the oscillation matches pattern A, go to step 8. • If the oscillation matches pattern B, increase GAIN (decrease PB) by a factor of 2 and repeat steps 4 to 6. • If the oscillation matches pattern C, decrease GAIN (increase PB) by a factor of 0.8 and repeat steps 4 to 6 The amplitude of the cycle is immaterial, but all of the elements of the loop must be within the operating range (i.e., the valve must not go full open or closed).
8	Record the current value of GAIN (or PB) and measure and record the value of time for one completed oscillation of PV

Continued on next page

A.2 Time, Position, or Current Proportional Simplex Control, Continued

Procedure, continued

Table A-1 Manual Tuning Procedure for Simplex Control, continued

Step	Action
9	Select the proper set of formulas from Table A-2. Use the values of Gain (or PB) and time (in minutes) in the formulas to arrive at the controller's tuning parameters settings.
A	Enter the values of GAIN (or PB), RATE, and RESET in minutes (or repeats per minute) into the UDC5000 controller and verify that the PV response is adequate. Make additional trimming adjustments, if necessary, to fine tune the controller per the guidelines shown below: TO REDUCE OVERSHOOT Less Gain (more PB) perhaps a longer Rate time. TO INCREASE OVERSHOOT OR INCREASE SPEED OR RESPONSE More Gain (less PB), perhaps shorter Rate time.

Manual tuning formulas Table A-2 lists the formulas used in the procedure listed in Table A-1.

Table A-2 Manual Tuning Formulas

	Units	
	GAIN and RESET TIME in $\frac{\text{Minutes}}{\text{Repeat}}$	% PROPORTIONAL BAND and RESET ACTION in $\frac{\text{Repeats}}{\text{Minutes}}$
Proportional (P) only Use PD–MR Algorithm (i.e. No Reset)	GAIN = Measured Gain x 0.5 RESET TIME = 50.00 (minimum reset) RATE = 0	%PB = Measured PB x 2 RESET ACTION = 0.02 (repeats/minute) RATE = 0
Proportional + Reset (PI) (No Rate)	GAIN = Measured Gain x 0.5 RESET TIME = $\frac{\text{Measured Time}}{1.2}$ (M/R) RATE = 0	%PB = Measured PB x 2.2 RESET ACTION = $\frac{1.2}{\text{Measured Time}}$ (R/M) RATE = 0
Proportional + Reset + Rate (PID)	GAIN = Measured Gain x 0.6 RESET TIME = $\frac{\text{Measured Time}}{2}$ RATE = $\frac{\text{Measured Time}}{8}$	%PB = Measured PB x 1.7 RESET ACTION = $\frac{2}{\text{Measured Time}}$ RATE = $\frac{\text{Measured Time}}{8}$

A.3 Time Proportional Duplex or Current Proportional Duplex Control

Introduction

For HEAT/COOL applications.
Tune the controller with the output above 50% for Heat and below 50% for Cool.

HEAT/COOL prompts

The "TUNING" function prompts for HEAT/COOL are:

HEAT	COOL
PROP BAND or GAIN	GAIN2
RSETMIN or RSETRPM	RSET2MIN or RSETRPM2
RATEMIN	RATE2MIN
CYCSEC	CYC2SEC

A.4 Two Sets of Tuning Parameters for Single Output Operation

Introduction

You can use two sets of tuning constants for single output types and tune each set separately.

TWO SETS prompts

The "TUNING" function prompts for two sets are:

PID SET 1	PID SET 2
PROP BAND or GAIN	GAIN2
RSETMIN or RSETRPM	RSET2MIN or RSETRPM2
RATEMIN	RATE2MIN
CYCSEC	CYC2SEC

A.5 Two Loops of Control

Introduction

You can use two sets of tuning constants on Loop 2 of a two Loop controller and tune each set separately

Loop 2 prompts

The "TUNING" function prompts for two sets on Loop 2 are:

PID SET 1	PID SET 2
PROP BAND3 or GAIN3	GAIN4
RSET3MIN or RSET3RPM	RSET4MIN or RSET4RPM
RATE3MIN	RATE4MIN
CYC3SEC	CYC4SEC

A.6 Internal Cascade

Introduction

When using two loops a Internal Cascade, tune the secondary loop (Loop 1) first, then tune the primary loop (Loop 2).

Procedure

Table A-3 is a suggested procedure for tuning Cascade Control.

Table A-3 Tuning Cascade Control

Step	Action
1	Place Loop 1 in local setpoint mode [or if left in cascade (RSP) mode, switch Loop 2 to manual mode] so Loop 1's setpoint will not be varying during the tuning of Loop 1.
2	Use "Start-up Mode" (See Subsection 5.16) to tune Loop 1 [alternatively, you could change Loop 1 local setpoint and use "SP ADAPT" to tune Loop 1] After tuning Loop 1, disable Adaptive on Loop 1.
3	Insure Loop 1 is placed in Cascade (RSP) mode and then use "Start-up Mode" to tune the primary loop (Loop 2). Verify that KPG (Process Gain) is set to 1.0 initially.
4	You can either disable Loop 2 tuning, or leave it "Enabled" after tuning.

Appendix B

How to Apply Digital Instrumentation in Severe Electrical Noise Environments

B.1 Overview

Guideline overview

Products that incorporate digital technology provide recognized performance advantages over conventional analog instrumentation used for process control. These advantages can result in better product uniformity and greater overall efficiency when used correctly.

There are, however, certain guidelines regarding installation and wiring which must be carefully followed in order to achieve this performance. In addition to the traditional precaution of the separation of signal and power wiring in separate conduits, other measures must be taken to minimize the effects of electromagnetic interference (EMI) and radio frequency interference (RFI) on the operation of the equipment. Otherwise, if high level, short duration, [illegible] to enter the digital equipment, the [illegible] transferred into the system's logic networks and can be misinterpreted as signal data, resulting in erroneous system operation and other unpredictable responses.

What's in this section

This section contains the following information:

B.2 Potential Noise Sources

Overview

Noise can enter electronic equipment via three methods of coupling, namely:

- Capacitive (or electrostatic)
- Inductive (or magnetic)
- Impedance.

Capacitive and inductive coupling

Capacitive and inductive coupling have the same essential effect — they couple current or voltage, without any actual connection of the two circuits. Impedance coupling requires a connection between the two circuits. Typical noise-generating sources that could affect electronic equipment through capacitive and inductive coupling include.

- Relay coils
- Solenoids
- AC power lines — particularly at or above 100 Vac
- Current carrying cables
- Thyristor field exciters
- Radio frequency transmissions.

Impedance coupled noise

Impedance-coupled noise may enter by way of the lines used to power the digital equipment or by way of improper grounding. Most power lines, at typical industrial locations, are far from noise-free. The noise on them can be generated in many ways, but are nearly always associated with switching circuits of some nature.

These include:

- Large relays
- Contactors
- Motor starters
- Business and industrial machines
- Power tools
- HID (high intensity discharge) lights
- Silicon controlled rectifiers (SCRs) that are phase-angled fired.

B.3 Prevention Methods

Introduction

There are three ways to prevent electrical noise from interfering with the operation of the electronic digital equipment.

- Built-in noise rejection
- Separation of signal and power lines
- Noise suppression at source

Built-in noise rejection

The first method is to design the digital equipment with a high degree of noise rejection built-in. This includes housing the equipment in a case that will provide shielding, liberal use of noise rejection filters and opto-isolators, and the use of noise suppressors on potential noise sources within the equipment itself. This, of course, is the responsibility of the manufacturer who usually performs extensive laboratory and field testing of newly designed digital equipment to insure the adequacy of its immunity to noise. As a minimum requirement, the equipment should be able to pass the tests outlined in the IEEE Standard 472-1974 *(Surge Withstand Capacity Tests)*.

Signal and power line separation

The second method is to prevent noise from getting on the signal and power lines that are connected to the equipment. This is achieved by proper separation and shielding of those lines. In some cases, separate power lines or special power line regulation or filtering may be required for satisfactory electronic digital equipment operation. It is the responsibility of the installer to follow good wiring practices.

Suppression at the source

The third prevention method is to suppress the noise at its source. This is the most effective but also the most difficult because it is not easy to identify all of the potential noise sources in a typical industrial installation. Therefore, "suppression" is usually a last resort for those extreme situations where the other methods are insufficient by themselves. See *Noise Suppression at Source* which follows.

B.4 Recommended Wiring Practices

General rules

- All wiring must conform to local codes and practices.
- Wires carrying similar types of signals (Table B-1) may be bundled together, but bundles with different types of signals must be kept separated to prevent inductive or capacitive coupling.

Wire bundling

Table B-1 shows what wiring should be bundled together to prevent inductive or capacitive coupling.

Table B-1 External Wiring

Wire Function		Bundle No.	Are Shielded Twisted Wires Recommended?
No.	Type		
 1 2 3 	HIGH VOLTAGE Line Power Earth Ground Line Voltage Digital I/O	1	NO
 4 5 	ANALOG I/O Process Variable RTD Thermocouple dc Millivolts Low level (<100V) 4-20 mA dc 1-5 Vdc	2	YES
 6 7	DIGITAL I/O Low Voltage (<100V) Computer Interface	3	YES

Continued on next page

Additional rules

Please observe these additional rules for wire bundling:

- For distances over five (5) feet, and when shielding is recommended, use a separate metal tray or conduit for each bundle. Where conduits or trays are not practical, use twisted wires with a metal overbraid and provide physical separation of at least one foot.
- Tray covers must be in continuous contact with the side rails of the trays.
- When unlike signal levels must cross, either in trays or conduits, they should cross at a 90-degree angle and at a maximum spacing. Where it is not possible to provide spacing, a grounded steel barrier or grid should be placed between the unlike levels at the crossover points.
- Trays containing low level wiring should have solid bottoms and sides. Tray covers must be used for complete shielding. Tray cover contact with side rails must be positive and continuous to avoid high reluctance air gaps, which impair shielding. Trays for low level cables should be metal and solidly grounded.
- Wires containing low level signals should not be routed near any of the following:
  - Contactors,
  - Motors,
  - Generators,
  - Radio transmitters, and
  - Wires carrying high current that is being switched on and off.
- Use a 12-gage (or heavier) insulated stranded wire for the ground connection. Attach it firmly to a proven good earth ground such as a metal stake driven into the ground.
- All shields should be grounded at one end only — preferably the instrument end.

B.5 Power Source Considerations

Operate within limits

The AC power for the digital electronic equipment must be within the voltage and frequency limits specified for that equipment. Attempts to operate outside the specified limits will result in no performance. For those installations where the supply voltage will not stay within the specified limits, a ferroresonant transformer, for voltage resolution, should be used.

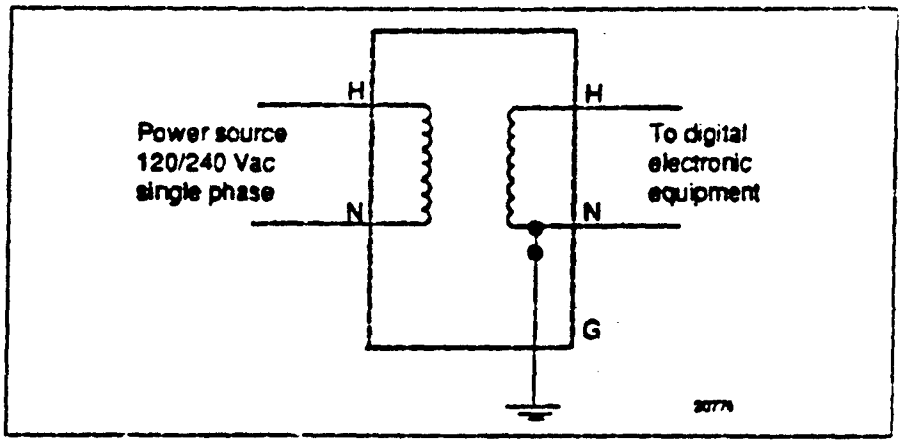
Independent AC source

For protection against noise, the AC source for the digital electronic equipment should be independent of all other loads especially when switching loads are involved. For example, it should not provide power for air-conditioning, convenience outlets, lighting, motors, or similar noise-generating devices. To obtain electrical isolation (see Figure B-1) a separate transformer is required to supply power to the digital equipment. For additional noise and transient rejection, shielded primary and secondary windings may be required. And, if necessary, power line filters may be added to attenuate noise signals that have a higher frequency than the power line frequency.

Transformer for digital equipment

Figure B-1 is an illustration of a separate transformer required to supply power to digital equipment.

Figure B-1 Transformer for Digital Equipment



B.6 Noise Suppression at the Source

Introduction

Generally speaking, when good wiring practices are used with well-designed digital electronic equipment, no further noise protection is necessary. However, in some severe electrical environments, the magnitude of the electrical noise is so great that it must be suppressed at the source. In most control cabinets, the main sources of noise are motor starters, contactors, relays, and switching gear. For this reason, many manufacturers of these devices supply "surge suppressors" which mount directly on the noise source, (for example, on the coil of a control relay or motor starter).

For those devices that do not have accessory "surge suppressors," resistance-capacitance (RC) circuits and/or voltage limiters such as metal varistors may be added when and where needed. This can be broken down into two categories, namely inductive loads (for example, a relay switch in series with a relay coil) and contacts.

Inductive coils

Metal Oxide Varistors (MOVs) are recommended for transient suppression in inductive coils. An MOV is connected in parallel with the coil and is as close as physically possible to the coil (see Figure B-2). MOV devices (listed in Table B-2) are recommended for general purpose applications.

Table B-2 lists part numbers for recommended MOV devices.

Table B-2 MOV Devices

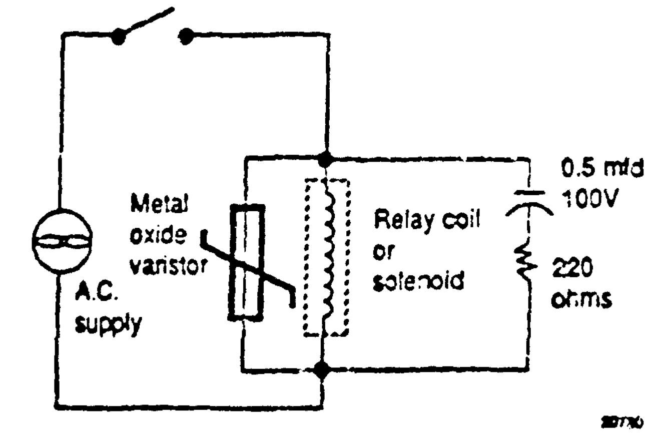
Part Number	30732481-001	30732481-002
Maximum AC	130V	275V
Energy Pulse Rating	10 Joules	15 Joules
Supplier (General Electric)	V130LA10A	V275LA15A

Continued on next page

Inductive coils, continued

Figure B-2 is an illustration of transient suppression in inductive coils.

Figure B-2 Transient Suppression in Inductive Coils



Additional protection may be provided by adding an RC circuit in parallel with the MOV. This consists of a 220-ohm resistor in series with a 0.5 microfarad, 1000V capacitor. The power rating of the resistor will depend on the voltage rating of the coil (see Table B-3).

Table B-3 Coil Voltage vs Resistor Voltage Rating

Coil Voltage	Resistor Voltage Rating
115V	1/4 Watt
230V	1 Watt
460V	3 Watt
550V	5 Watt

Continued on next page

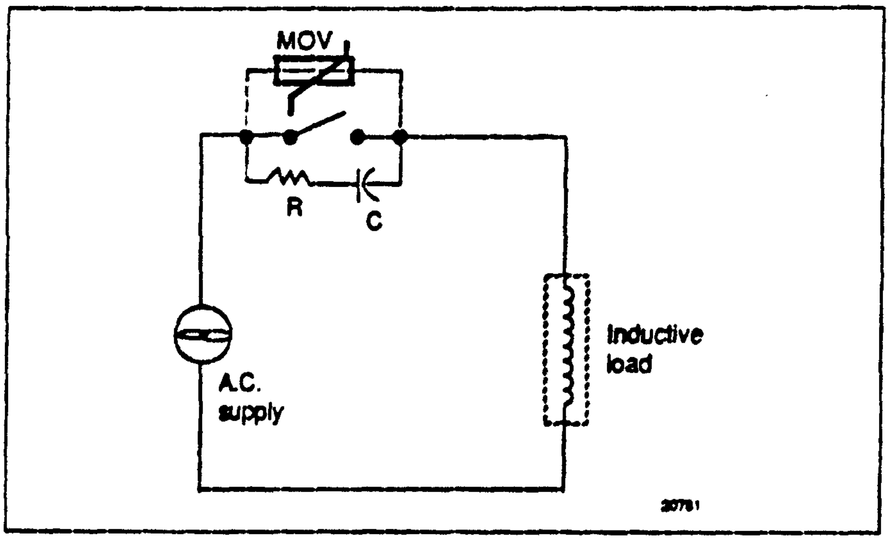
Contacts

When a contact interrupts an inductive load, a certain amount of energy is stored in the load. An MOV or RC circuit in parallel with the load provides a place where this energy may be dissipated. However, if there is no MOV or RC circuit, the energy may create a visible electrical arc across the open contacts. This, in turn, results in electrical noise as well as damage to the contacts.

One way to eliminate this arc is to connect a resistor and capacitor across the contacts (see Figure B-3). A combination of 47 ohms and 0.1 microfarads (1000 Vdc) is recommended for circuits up to 3 amps and 300 Vac. For voltages above 2000 Vac, an MOV across the contact may be added for extra protection.

Figure B-3 is an illustration of a resistor and capacitor connected across a contact to eliminate electrical noise.

Figure B-3 Contact Noise Suppression



For large load currents, a rule of thumb is to size the capacitor so that the number of microfarads equals the number of amperes in the load current, and the resistor has the same resistance value as the load. The objective is to eliminate the visible arc.

Either discreet resistors and capacitors or packaged RC networks may be used. An RC network (47 ohms and 0.1 microfarad) is available from Honeywell as part number 30371852-001. Similar RC networks are available from Electrocube Inc. (part number RG1782-3) and from Industrial Condensor Corporation.

Continued on next page

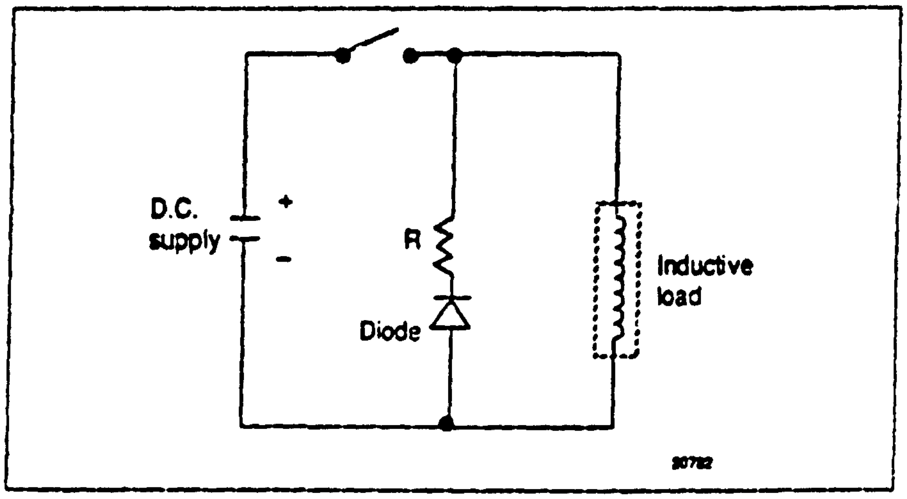
B.6 Noise Suppression at the Source, continued

Contacts, continued

In DC circuits, the power dissipation under steady state condition can be eliminated by placing a diode (in series with a resistor) in parallel with the load (see Figure B-4). The value of R should be less than or equal to the DC resistance of the inductive load.

Figure B-4 is an illustration of DC load noise suppression.

Figure B-4 DC Load Noise Suppression



Index

K, L

M, N

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P, Q

R

S

T

U, V, W, X, Y, Z

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Publication Number: 51-51-25-17D Issue Date: 9/94

Writer: Dan O'Connor

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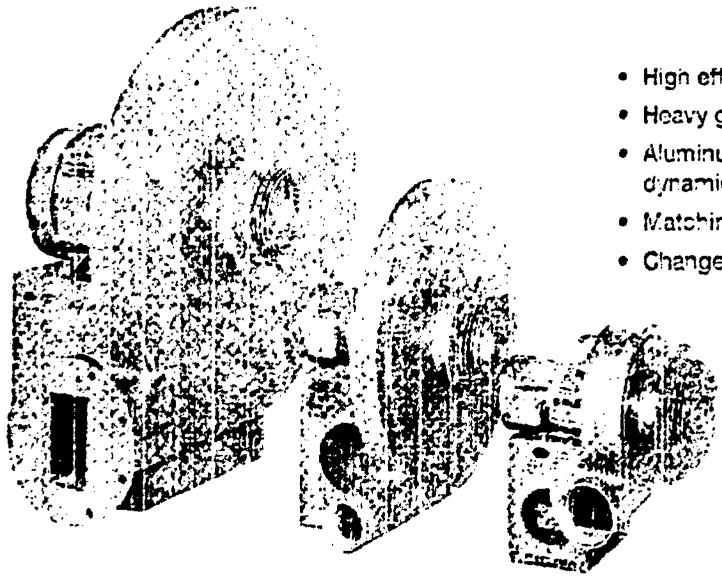
Bulletin 610
2/94

ECLIPSE TURBO BLOWERS
SERIES "SMJ"



- High efficiency
- Heavy gauge steel base and housing
- Aluminum impellers balanced statically and dynamically
- Matching air filters available
- Changeable outlet positions

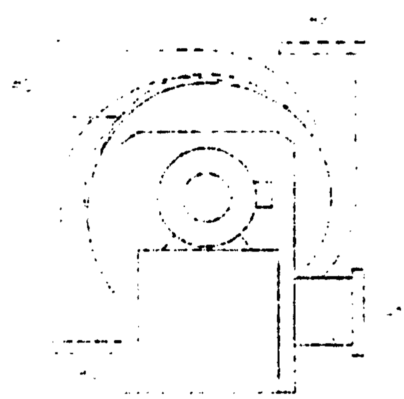
Eclipse "SMI" Blowers are centrifugal blowers that provide low pressure air for industrial combustion systems. They are also used for cooling, conveying, drying, liquid agitation, smoke abatement, vacuum cleaning, fume and dust exhausting, and other applications where air temperatures are under 220°F (104°C).

All "SMI" Blowers are constructed of continuous welded, heavy gauge steel. The impellers are made of lightweight, high strength, riveted aluminum. Outlets on 3" and 4" models are threaded, while all others are flanged for a standard 125# ANSI companion flange. Discharge ports are sized to keep pressure losses within reasonable limits.

Blower inlet flanges are equipped with a grill that complies with OSHA regulations. If desired, the grill may be removed and the inlet bolted to a standard ANSI companion flange. Four series, polled motors are standard shaft and starting torque, ball bearing, 3600 rpm units. On any blower requiring 3/4 HP or more, Eclipse recommends that polyphase motors be used.

There are four possible outlet positions. Any existing position is easily changed by removing the housing [illegible] and [illegible] in the desired position. Positions 1 through 3 can be specified for any blower. Position 4, however, requires factory approval before ordering. Position 1 is the standard assembly (bottom, horizontal) unless otherwise specified.

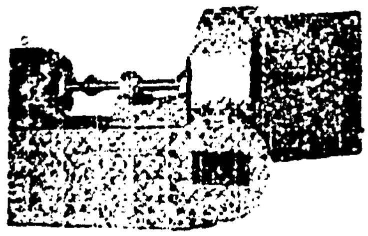
"SMJ" Blowers can be supplied with counterclockwise (CCW) or clockwise (CW) rotation as viewed from the motor side. CCW rotation is furnished standard unless otherwise specified.



Outlet Positions

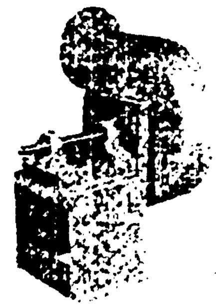
ECLIPSE COMBUSTION

Model Variations



Type "D"
A.M.C.A. Arrangement #8

[illegible]



Type "P"
A.M.C.A. Arrangement #1

Type "P" construction permits the blower to be driven by a gasoline engine, line shaft or other separate power source.

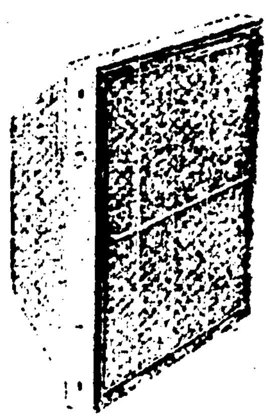
Type "V"
A.M.C.A. Arrangement #9

Type "V" construction is normally used when 60 cycle AC current is not available and motor speeds result in less than standard rpm. The V belt drives the impeller at standard rpm regardless of motor speed.

Air Inlet Filters

Filters must be ordered separately.

Single
Washable Element
(Double Also Available)
Bulletin 615



Non-washable
Cylindrical Element
Bulletin 616

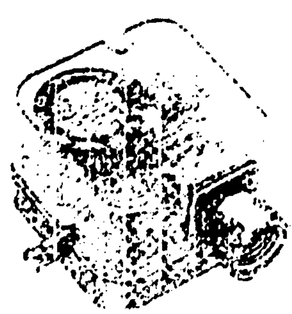
Round
Replaceable Element
Bulletin 614

Round Filters

Catalog No.	Assy. No.	Blower Inlet Size	Max. Capacity	
			SCFH	m³/hr.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Pressure Switches



Model AA-4[illegible]
Bulletin [illegible]

[illegible]

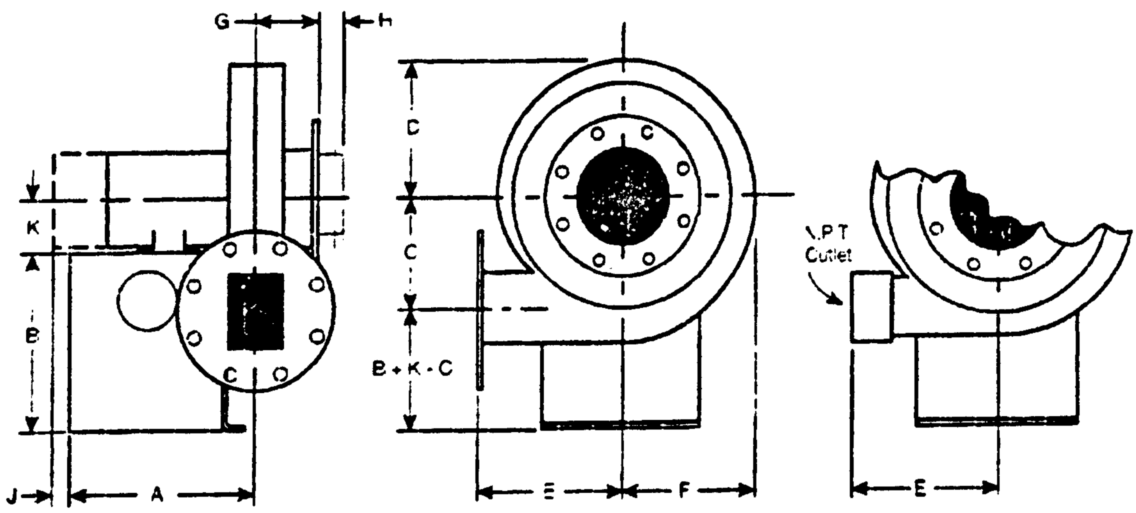
Capacities–3600 rpm Motor

Blower Catalog No.	Motor HP	Service Factor	Inlet Size	Nominal Rating "w.c.	SCFH	mbar	m³/hr.
SMJ 4610	1/3	1.35	6	7.0	6,900*	17.4	195*
SMJ 4610	1/2	1.25	6	7.0	15,000*	17.4	425*
SMJ 6812	1-1/2	1.15	8	9.5	40,300*	23.7	1,141*
SMJ 3412	1/3	1.35	4	10.0	4,800*	24.9	136*
SMJ 4412	1/2	1.25	4	10.0	8,600*	24.9	243*
SMJ 4412	3/4	1.25	4	10.0	14,000*	24.9	396*
SMJ 6812	1	1.25	8	10.0	32,800	24.9	929
SMJ 6812	2	1.15	8	10.0	45,000*	24.9	1,274*
SMJ 8815	5	1.15	8	10.4	92,500	25.9	2,620
SMJ 8814	3	1.15	8	11.0	69,000	27.4	1,954
SMJ 8813	3	1.15	8	11.5	72,000	28.6	2,039
SMJ 6814	2	1.15	6	11.6	44,600	28.9	1,263
SMJ 6614	1-1/2	1.15	6	13.0	37,000	31.1	1,046
SMJ 3414	3/4	1.25	4	14.0	10,000*	34.9	283*
SMJ 4614	1	1.25	6	14.0	21,200	34.9	600
SMJ 101016	7-1/2	1.15	10	14.1	140,400	35.1	3,976
SMJ 3414	1/2	1.25	4	14.7	7,530	36.6	213
SMJ 6615	2	1.15	6	15.0	32,000	37.4	906
SMJ 4615	1	1.25	6	15.5	23,000	38.6	651
SMJ 4616	1-1/2	1.15	6	15.5	27,000	38.6	765
SMJ 121217	15	1.15	12	15.6	223,000	38.9	6,315
SMJ 4615	3/4	1.25	6	15.8	13,600	39.4	385
SMJ 101016	10	1.15	10	16.0	163,000	39.9	4,616
SMJ 8816	5	1.15	8	17.0	70,000*	42.3	1,982*
SMJ 101016	7-1/2	1.15	10	17.0	86,000*	42.3	2,436*
SMJ 8815	3	1.15	8	17.1	52,000	42.6	1,473
SMJ 121217	10	1.15	12	19.1	150,000	47.6	4,248
SMJ 6617	2	1.15	6	19.6	25,700	48.8	728
SMJ 6617	3	1.15	6	19.9	38,000	49.6	1,076
SMJ 4617	1-1/2	1.15	6	20.0	15,000*	49.8	425*
SMJ 8817	7-1/2	1.15	8	20.0	85,000*	49.8	2,407*
SMJ 101018	15	1.15	10	20.0	165,000*	49.8	4,673*
SMJ 4616	1	1.25	6	20.2	16,500	50.3	467
SMJ 8817	5	1.15	8	21.2	67,500	52.8	1,912
SMJ 121220	20	1.15	12	26.0	202,000	64.8	5,721
SMJ 3619	1-1/2	1.15	6	27.0	15,300	67.3	433
SMJ 3619	2	1.15	6	27.0	20,000	67.3	566
SMJ 4619	2	1.15	6	27.0	20,000	67.3	566
SMJ 6619	5	1.15	6	27.4	49,100	68.3	1,391
SMJ 6619	3	1.15	6	27.8	27,300	69.2	773
SMJ 8819	7-1/2	1.15	8	27.8	70,500	69.2	1,997
SMJ 121219	15	1.15	12	27.8	150,000	69.2	4,248
SMJ 101019	10	1.15	10	28.4	87,500	70.7	2,478
SMJ 121221	25	1.15	12	30.0	209,000*	74.7	5,919*
SMJ 6621	3	1.15	6	31.0	18,300	77.2	518
SMJ 6621	5	1.15	6	31.5	36,800	78.5	1,042
SMJ 4621	2	1.15	6	32.1	9,100	80.0	258
SMJ 8821	7-1/2	1.15	8	32.3	48,000	80.5	1,359
SMJ 8821	10	1.15	8	32.6	74,500	81.2	2,110
SMJ 101021	20	1.15	10	34.0	133,000*	84.7	3,767*
SMJ 101021	15	1.15	10	34.2	121,500	85.2	3,441
SMJ 121222	25	1.15	12	35.4	213,000	88.2	6,032
SMJ 4623	3	1.15	6	37.2	11,600	92.7	328
SMJ 101023	25	1.15	10	38.6	178,000	96.1	5,041
SMJ 8823	15	1.15	8	38.9	102,000	96.9	2,889
SMJ 6623	7-1/2	1.15	6	39.0	42,500	97.1	1,204
SMJ 101023	20	1.15	10	39.8	136,000	99.1	3,852
SMJ 8823	10	1.15	8	40.5	60,000	100.9	4,531
SMJ 4623	5	1.15	6	41.1	29,500	102.4	835
SMJ 6628	10	1.15	6	54.6	40,000	136.5	1,133
SMJ 4628	5	1.15	6	55.0	14,500	137.0	411
SMJ 4628	7-1/2	1.15	6	55.8	28,100	139.0	796
SMJ 8828	15	1.15	8	58.5	63,000	145.7	1,784
SMJ 8828	25	1.15	8	59.0	95,000*	147.0	2,690*
SMJ 8828	20	1.15	8	60.0	91,000	149.5	2,577

Pressures are corrected for an air inlet temperature of 70°F (21°C) and a barometric pressure of 29.92" Hg (1.01 bar).

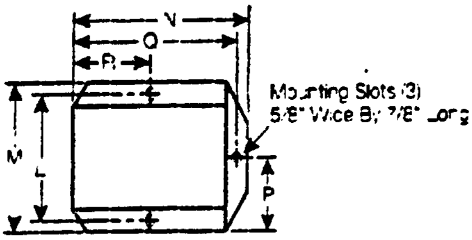
*Greater flows available at reduced pressure. See blower curves for details (Data 610).

Dimensions & Specifications - English Units



Flanged Outlet

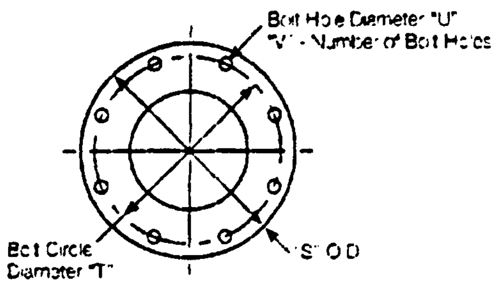
Threaded Outlet



Base*	Dimensions, In Inches						Bolt Dia.
	L	M	N	P	Q	R	
1	7-3/4	9-3/4	10	4-7/8	9	3-7/8	1/2
2	9-1/4	11-1/4	11	5-5/8	10	4-3/8	1/2
3	10	12	11-1/2	6	11	4-5/8	1/2
4	11	13	12	6-1/2	11	4-7/8	1/2
5	12	14	15-1/2	7	14-1/2	6-5/8	1/2
6	13-3/4	15-3/4	17-1/2	7-7/8	16-1/2	7-5/8	1/2
7	17	19	19-1/2	9-1/2	18-1/2	8-5/8	1/2

*See the main dimension table to find the base used on each blower

Flange Dimensions



Nominal Pipe Size	Dimensions, In Inches				Bolt Dia.
	S	T	U	V	
3	7-1/2	6	3/4	4	5/8
4	9	7-1/2	3/4	8	5/8
6	11	9-1/2	7/8	8	3/4
8	13-1/2	11-3/4	7/8	8	3/4
10	16	14-1/4	1	12	7/8
12	19	17	1	12	7/8

Flange bolt patterns match ANSI 125# standards

Dimension "K" And Blower Motor Specifications

All motors are 3600 RPM.

HP	Encl.	Frame Size	S.F.	Dim. "K" (Inches)	V./Ph./Hz.	Part
1/3	Open	48	1.35	3	115/230/1/60	11175
1/3	TEFC	48	1.35	3	115/230/1/60	10755
1/3	Open	48	1.35	3	230/460/3/60	17745
1/3	TEFC	48	1.35	3	230/460/3/60	10448
1/2	Open	48	1.25	3	115/230/1/60	11180
1/2	TEFC	48	1.25	3	115/230/1/60	18776
1/2	Open	48	1.25	3	230/460/3/60	11178
1/2	TEFC	48	1.25	3	230/460/3/60	10449
1/2	Open	56	1.25	3-1/2	230/460/3/60	10047
1/2	TEFC	56	1.25	3-1/2	230/460/3/60	10032
3/4	Open	56	1.25	3-1/2	115/230/1/60	11182
3/4	TEFC	56	1.25	3-1/2	115/230/1/60	18777
3/4	Open	56	1.25	3-1/2	230/460/3/60	11183
3/4	TEFC	56	1.35	3-1/2	230/460/3/60	17723
1	Open	56	1.25	3-1/2	115/230/1/60	11187
1	TEFC	56	1.25	3-1/2	230/460/3/60	16291
1	Open	56	1.25	3-1/2	230/460/3/60	11189
1-1/2	Open	56	1.15	3-1/2	115/230/1/60	16742
1-1/2	Open	143T	1.15	3-1/2	230/460/3/60	11192
1-1/2	TEFC	143T	1.15	3-1/2	230/460/3/60	11197
2	Open	145T	1.15	3-1/2	230/460/3/60	11203
2	TEFC	145T	1.15	3-1/2	230/460/3/60	11199
3	Open	145T	1.15	3-1/2	230/460/3/60	11207
3	TEFC	182T	1.15	4-1/2	230/460/3/60	11209
5	Open	182T	1.15	4-1/2	230/460/3/60	11213
5	TEFC	184T	1.15	4-1/2	230/460/3/60	11210
7-1/2	Open	184T	1.15	4-1/2	230/460/3/60	11214
7-1/2	TEFC	213T	1.15	5-1/4	230/460/3/60	11215
10	Open	213T	1.15	5-1/4	230/460/3/60	11216
10	TEFC	215T	1.15	5-1/4	230/460/3/60	11217
15	Open	215T	1.15	5-1/4	230/460/3/60	11221
15	TEFC	254T	1.15	5-1/4	230/460/3/60	11220
20	Open	254T	1.15	5-1/4	230/460/3/60	11224
20	TEFC	256T	1.15	5-1/4	230/460/3/60	19894
25	Open	256T	1.15	5-1/4	230/460/3/60	14072
25	TEFC	264T	1.15	7	230/460/3/60	16764

Dimensions & Specifications–English Units (continued)

Blower Catalog No.	Motor HP[1]	Inlet	Outlet	Dimensions In Inches A	B	C	D	E	F	G	H	J	Base[2]
SMJ 3412[3]	1/3	4	3	9-3/16	9-1/2	7-1/2	8-3/8	10-1/8	8-11/16	4	1-7/8	—	1
SMJ 3414[3]	1/2 & 3/4	4	3	10	9-1/2	8-5/16	9-3/16	10-9/16	9-9/16	3-13/16	1-7/8	—	2
SMJ 3414	1/2 & 3/4	4	3	10	9-1/2	8-5/16	9-3/16	10-9/16	9-9/16	3-13/16	1-7/8	—	2
SMJ 3619[3]	1-1/2 & 2	6	3	11-3/16	12-1/2	11-3/4	13	15-5/8	13-5/16	4	1-7/8	—	4
SMJ 4412[3]	1/2	4	4	9-5/8	9-1/2	6-1/2	7-7/8	10-13/16	8-1/16	4-7/16	1-7/8	—	1
SMJ 4412[3]	3/4	4	4	10-5/8	9-1/2	6-1/2	7-7/8	10-13/16	8-1/16	4-7/16	1-7/8	—	1
SMJ 4610[3]	1/3 & 1/2	6	4	9-13/16	9-1/2	5-13/16	6-11/16	9-13/16	6-7/8	4-5/8	1-7/8	1-1/4	1
SMJ 4614[3]	1	6	4	11-1/2	12-1/2	8-11/16	10	13-13/16	10-3/16	4-5/16	1-7/8	—	4
SMJ 4615[3]	3/4 & 1	6	4	11-1/2	12-1/2	8-11/16	10	13-13/16	10-3/16	4-5/16	1-7/8	—	4
SMJ 4616[3]	1 & 1-1/2	6	4	11-3/8	12-1/2	9-1/2	11-1/8	14-13/16	11-5/16	4-3/16	1-7/8	—	4
SMJ 4617[3]	1-1/2	6	4	11-3/8	12-1/2	9-1/2	11-1/8	14-13/16	11-5/16	4-3/16	1-7/8	—	4
SMJ 4619[3]	2	6	4	11-1/4	12-1/2	11-3/4	13	15-13/16	13-5/16	4	1-7/8	—	4
SMJ 4621	2	6	4	15-3/16	15-1/2	12-3/4	14-3/8	16-7/8	14-1/2	4-1/2	1-7/8	—	5
SMJ 4623	3	6	4	15-5/16	15-1/2	13-9/16	14-11/16	15-3/8	15-3/8	4-5/8	1-7/8	—	5
SMJ 4623	5	6	4	15-5/16	15-1/2	14	15-1/16	15-3/8	15-3/8	4-5/8	1-7/8	—	5
SMJ 4628	5 & 7-1/2	6	4	17-1/16	19	15-7/8	16-3/16	18-3/8	18-1/2	4-9/16	1-7/8	—	6
SMJ 6614	1-1/2 & 2	6	6	12-7/16	12-1/2	8-1/4	9-13/16	12-3/8	10	5-1/4	1-7/8	—	4
SMJ 6615	2	6	6	12-7/16	12-1/2	8-1/4	9-13/16	12-3/8	10	5-1/4	1-7/8	—	4
SMJ 6617	2 & 3D	6	6	11-7/8	12-1/2	9-3/8	11-1/8	13-3/8	11-1/4	4-3/4	1-7/8	—	4
SMJ 6617	3E	6	6	11-7/8	12-1/2	9-3/8	11-1/8	13-3/8	11-1/4	4-3/4	1-7/8	1/2	5
SMJ 6619	3	6	6	15-3/16	15-1/2	11-3/4	13	14-3/8	13-5/16	4-1/2	1-7/8	—	5
SMJ 6619	5	6	6	15-3/16	15-1/2	11-3/4	13	14-3/8	13-5/16	5-3/4	1-7/8	—	5
SMJ 6621	3 & 5	6	6	14-3/4	15-1/2	12	14-1/16	14-3/8	14-9/16	4-1/16	1-7/8	—	5
SMJ 6623	7-1/2	6	6	15-15/16	15-1/2	12-9/16	15	17-3/8	15-1/4	5-3/16	1-7/8	—	5
SMJ 6812	1,1-1/2,2D	8	6	12	12-1/2	7-5/16	8-7/16	10-3/8	8-13/16	5-1/4	1-7/8	—	3
SMJ 6812	2E	8	6	12	12-1/2	7-5/16	8-7/16	10-3/8	8-13/16	5-1/4	1-7/8	1/2	3
SMJ 8813	3D	8	8	14-1/2	12-1/2	8-7/8	10	12-3/8	10-9/16	7-5/16	1-7/8	—	4
SMJ 8813	3E	8	8	14-1/2	12-1/2	8-7/8	10	12-3/8	10-9/16	7-5/16	1-7/8	9/16	4
SMJ 8814	3	8	8	16	15-1/2	9-11/16	11-1/4	12-3/8	12-1/16	5-1/4	1-7/8	—	5
SMJ 8815	3 & 5	8	8	16	15-1/2	9-11/16	11-1/4	12-3/8	12-1/16	5-1/4	1-7/8	—	5
SMJ 8816	5	8	8	16	15-1/2	9-11/16	11-1/4	12-3/8	12-1/16	5-1/4	1-7/8	—	5
SMJ 8817	5 & 7-1/2	8	8	15-7/16	15-1/2	9-7/8	11	13-7/8	11-7/8	5-3/4	1-7/8	—	5
SMJ 8819	7-1/2 & 10	8	8	16-1/8	15-1/2	13	14-5/16	15-3/8	15-3/16	5-7/16	1-7/8	—	5
SMJ 8821	7-1/2 & 10	8	8	18-1/2	19	14	15-1/2	15-3/8	16-7/16	5-3/4	1-7/8	—	6
SMJ 8823	10 & 15	8	8	20-1/8	19	14-9/16	16	16-3/8	16-7/8	5-1/2	1-7/8	—	7
SMJ 8828	10 & 15D	8	8	19-1/2	19	15-1/4	18-1/8	22-3/8	18-3/8	4-7/8	1-7/8	—	7
SMJ 8828	15E,20 25D	8	8	19-1/2	19	15-1/4	18-1/8	22-3/8	18-3/8	4-7/8	1-7/8	1-9/16	7
SMJ 8828	25E	8	8	19-1/2	19	15-1/4	18-1/8	22-3/8	18-3/8	4-7/8	1-7/8	3-1/8	7
SMJ 101016	7-1/2	10	10	18-11/16	15-1/2	10-13/16	12	14-3/8	12-3/4	8	2-3/8	—	5
SMJ 101016	10	10	10	20-11/16	19	10-13/16	12	14-3/8	12-3/4	8	2-3/8	—	6
SMJ 101018	15D	10	10	20-1/4	19	12-1/4	13-1/4	14-3/8	14-9/16	7-9/16	2-3/8	—	6
SMJ 101018	15E	10	10	20-1/4	19	12-1/4	13-1/4	14-3/8	14-9/16	7-9/16	2-3/8	1-7/8	6
SMJ 101019	10	10	10	19 3/4	19	13	14-3/8	15-3/8	15-1/4	7-1/16	2-3/8	—	6
SMJ 101021	15 & 20	10	10	21-7/16	19	14	15 1/2	15-3/8	16-7/16	6-3/4	2-3/8	—	7
SMJ 101023	20	10	10	20-13/16	19	14-3/16	16	18-3/8	17	6-3/16	2-3/8	—	7
SMJ 101023	25D	10	10	20-13/16	19	14-3/16	16	18-3/8	17	6-3/16	2-3/8	1-5/8	7
SMJ 101023	25E	10	10	20-13/16	19	14-3/16	16	18-3/8	17	6-3/16	2-3/8	3-1/8	7
SMJ 121217	10 & 15D	12	12	20-11/16	19	10-13/16	12	14-3/8	12-3/4	8	2-3/8	—	6
SMJ 121217	15E	12	12	20-11/16	19	10-13/16	12	14-3/8	12-3/4	8	2-3/8	1-3/4	6
SMJ 121219	15D	12	12	23	19	13	14-1/2	15-3/8	15-1/4	8-1/4	2-3/8	—	7
SMJ 121219	15E	12	12	23	19	13	14-1/2	15-3/8	15-1/4	8-1/4	2-3/8	—	7
SMJ 121220	20	12	12	23	19	13	14 1/2	15-3/8	15-1/4	8-1/4	2-3/8	—	7
SMJ 121221	25D	12	12	22-1/16	19	14	15-9/16	15-3/8	16-7/16	7-3/8	2-3/8	1-5/8	7
SMJ 121221	25E	12	12	22-1/16	19	14	15-9/16	15-3/8	16-6/16	7-3/8	2-3/8	3-1/8	7
SMJ 121222	25D	12	12	22-1/16	19	14	15-9/16	15-3/8	16-7/16	7-3/8	2-3/8	1-5/8	7
SMJ 121222	25E	12	12	22-1/16	19	14	15-9/16	15-3/8	16-7/16	7-3/8	2-3/8	3-1/8	7

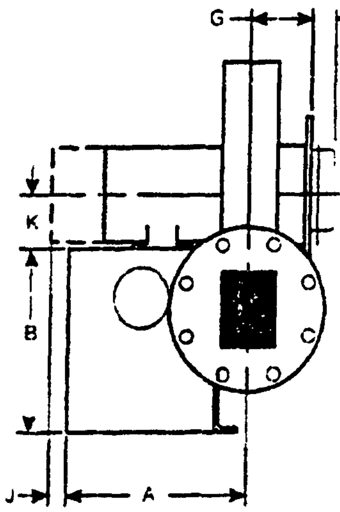
[1] D=open motor; E=enclosed motor. Horsepowers with no letter suffix are either open or enclosed.

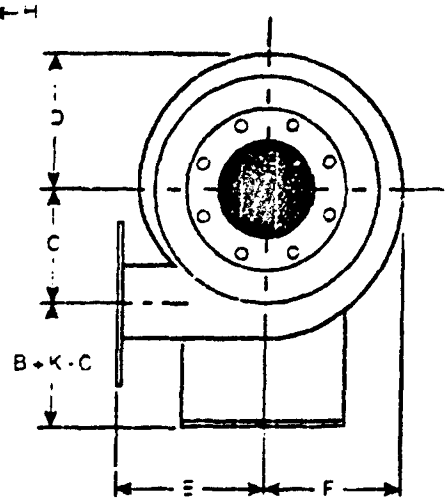
[2] Refer to the base chart on page 4 for base mounting dimensions.

[3] Signifies an N.P.T. threaded outlet. All other blowers have flanged outlets with standard ANSI 125# bolt patterns. All inlets are flanged. Companion flanges are not standard but are available at a nominal cost.

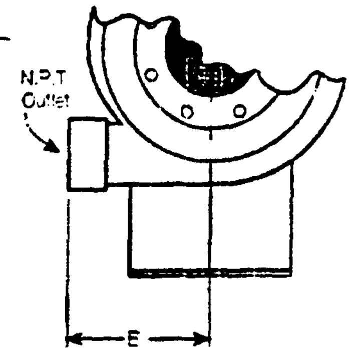
To Order: Specify blower catalog number, CW or CCW rotation, motor HP, open or TEFC, voltage and frame size.

Dimensions & Specifications – Metric Units

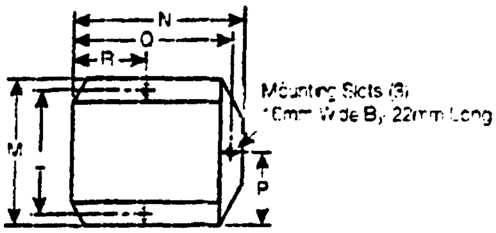




Flanged Outlet



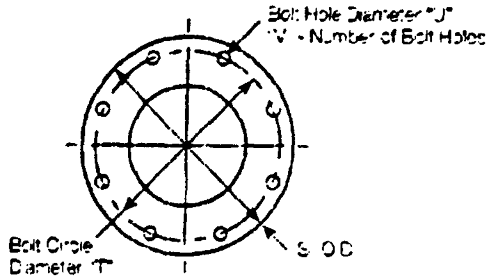
Threaded Outlet



Base*	Dimensions (mm) L	M	N	P	Q	R	Bolt Dia.
1	197	248	254	124	229	98	14
2	235	288	279	143	254	111	14
3	254	305	292	152	279	117	14
4	279	330	305	165	279	124	14
5	305	356	394	178	368	168	14
6	349	400	445	200	419	194	14
7	432	483	495	241	470	219	14

* See the main dimension table to find the base used on each blower

Flange Dimensions



Nominal Pipe Size	Dimensions (mm) S	T	U	V	Bolt Dia.
76	191	152	19	4	16
102	229	191	19	8	16
152	279	241	22	8	19
203	343	298	22	8	19
254	406	362	25	12	22
305	483	432	25	12	22

Flange bolt pattern is match ANSI 125# standard.

Dimension "K" And Blower Motor Specifications

All motors are 3600 RPM.

HP	Encl.	Frame Size	S.F.	Dim. "K" (mm)	V./Ph./Hz.	Part
1/3	Open	48	1.35	76	115/230/1/60	11175
1/3	TEFC	48	1.35	76	115/230/1/60	10765
1/3	Open	48	1.35	76	230/460/3/60	17745
1/3	TEFC	48	1.35	76	230/460/3/60	10448
1/2	Open	48	1.25	76	115/230/1/60	11180
1/2	TEFC	48	1.25	76	115/230/1/60	18776
1/2	Open	48	1.25	76	230/460/3/60	11178
1/2	TEFC	48	1.25	76	230/460/3/60	10449
1/2	Open	56	1.25	89	230/460/3/60	10047
1/2	TEFC	56	1.25	89	230/460/3/60	10032
3/4	Open	56	1.25	89	115/230/1/60	11182
3/4	TEFC	56	1.25	89	115/230/1/60	18777
3/4	Open	56	1.25	89	230/460/3/60	11183
3/4	TEFC	56	1.35	89	230/460/3/60	17723
1	Open	56	1.25	89	115/230/1/60	11187
1	TEFC	56	1.25	89	230/460/3/60	18381
1	Open	56	1.25	59	230/460/3/60	11189
1-1/2	Open	56	1.15	69	115/230/1/60	16742
1-1/2	Open	143T	1.15	69	230/460/3/60	11192
1-1/2	TEFC	143T	1.15	89	230/460/3/60	11197
2	Open	145T	1.15	89	230/460/3/60	11203
2	TEFC	145T	1.15	89	230/460/3/60	11199
3	Open	145T	1.15	89	230/460/3/60	11207
3	TEFC	182T	1.15	114	230/460/3/60	11209
5	Open	182T	1.15	114	230/460/3/60	11213
5	TEFC	184T	1.15	114	230/460/3/60	11210
7-1/2	Open	184T	1.15	114	230/460/3/60	11214
7-1/2	TEFC	213T	1.15	133	230/460/3/60	11215
10	Open	213T	1.15	133	230/460/3/60	11218
10	TEFC	215T	1.15	133	230/460/3/60	11217
15	Open	215T	1.15	133	230/460/3/60	11221
15	TEFC	254T	1.15	159	230/460/3/60	11220
20	Open	254T	1.15	159	230/460/3/60	11224
20	TEFC	256T	1.15	159	230/460/3/60	19884
25	Open	256T	1.15	159	230/460/3/60	14072
25	TEFC	284T	1.15	178	230/460/3/60	18764

Dimensions & Specifications–Metric Units (continued)

Blower Catalog No.	Motor HP[1]	Inlet	Outlet	Dimensions In Millimeters A	B	C	D	E	F	G	H	J	Base[2]
SMJ 3412[3]	1/3	102	3" NPT	233	241	191	213	257	221	102	48	—	1
SMJ 3414[3]	1/2 & 3/4	102	3" NPT	254	241	211	233	269	243	97	48	—	2
SMJ 3414	1/2 & 3/4	102	76	254	241	211	233	269	243	97	48	—	2
SMJ 3519[3]	1-1/2 & 2	152	3" NPT	284	316	298	330	397	335	102	48	—	4
SMJ 4412[3]	1/2	102	4" NPT	244	241	165	200	275	206	113	48	—	1
SMJ 4412[3]	3/4	102	4" NPT	270	241	165	200	275	206	113	48	—	[illegible]
SMJ 4610[3]	1/3 & 1/2	152	4" NPT	249	241	148	170	249	175	117	48	32	[illegible]
SMJ 4614[3]	1	152	4" NPT	292	318	221	254	351	259	110	48	—	4
SMJ 4615[3]	3/4 & 1	152	4" NPT	292	318	221	254	351	259	110	48	—	4
SMJ 4616[3]	1 & 1-1/2	152	4" NPT	289	318	241	283	376	303	106	48	—	4
SMJ 4617[3]	1-1/2	152	4" NPT	289	318	241	283	376	303	106	48	—	4
SMJ 4619[3]	2	152	4" NPT	286	318	298	330	402	339	102	48	—	4
SMJ 4621	2	152	102	386	394	324	365	429	308	114	48	—	5
SMJ 4623	3	152	102	389	394	344	373	391	391	117	48	—	5
SMJ 4623	5	152	102	389	394	356	383	391	391	117	48	—	5
SMJ 4628	5 & 7-1/2	152	102	433	483	429	462	467	472	116	48	—	6
SMJ 6614	1-1/2 & 2	152	152	316	318	210	249	314	254	133	48	—	4
SMJ 6615	2	152	152	316	318	210	249	314	254	133	48	—	4
SMJ 6617	2 & 3D	152	152	302	318	238	283	340	288	121	48	13	4
SMJ 6617	3E	152	152	302	318	238	283	340	288	121	48	—	4
SMJ 6619	3	152	152	386	394	298	330	365	338	114	48	—	4
SMJ 6619	5	152	152	386	394	298	330	365	338	146	48	—	5
SMJ 6621	3 & 5	152	152	375	394	305	357	365	370	103	48	—	5
SMJ 6623	7-1/2	152	152	405	394	319	381	441	397	132	48	—	5
SMJ 6812	1 1-1/2,2D	203	152	305	318	186	214	264	224	133	48	—	3
SMJ 6812	2E	203	152	305	318	186	214	264	224	133	48	13	3
SMJ 8813	3D	203	203	368	318	225	254	314	268	166	48	—	4
SMJ 8813	3E	203	203	368	318	225	254	314	268	166	48	14	4
SMJ 8814	3	203	203	406	394	246	286	314	306	133	48	—	5
SMJ 8815	3 & 5	203	203	406	394	246	286	314	306	133	48	—	5
SMJ 8816	5	203	203	406	394	246	286	314	308	133	48	—	5
SMJ 8817	5 & 7-1/2	203	203	418	394	251	279	352	302	146	48	—	5
SMJ 8819	7-1/2 & 10	203	203	410	394	330	364	391	386	136	48	—	5
SMJ 8821	7-1/2 & 10	203	203	470	483	356	394	391	418	133	48	—	6
SMJ 8823	10 & 15	203	203	511	483	370	406	416	429	140	48	—	7
SMJ 8828	10 & 15D	203	203	495	483	367	460	568	467	124	48	—	7
SMJ 8828	15E,20,25D	203	203	495	483	367	460	568	467	124	48	40	7
SMJ 8828	25F	203	203	495	483	367	460	568	467	124	48	79	7
SMJ 101016	7-1/2	254	254	475	394	275	305	355	324	203	60	—	5
SMJ 101016	10	254	254	525	483	275	305	355	324	203	60	—	6
SMJ 101018	15D	254	254	514	483	311	337	365	370	192	60	—	6
SMJ 101018	15E	254	254	514	483	311	337	365	370	192	60	46	6
SMJ 101019	10	254	254	502	483	330	365	391	387	179	60	—	6
SMJ 101021	15 & 20	254	254	545	483	356	394	391	418	171	60	—	7
SMJ 101023	20	254	254	529	483	376	406	457	432	157	60	—	7
SMJ 101023	25D	254	254	529	483	370	406	457	432	157	60	41	7
SMJ 101023	25E	254	254	529	483	370	406	457	432	157	60	79	7
SMJ 121217	10 & 15D	305	305	525	483	275	305	365	324	203	60	—	6
SMJ 121217	15E	305	305	525	483	275	305	365	324	203	60	44	6
SMJ 121219	15D	305	305	584	483	330	368	391	387	210	60	—	7
SMJ 121219	15E	305	305	584	483	330	368	391	387	210	60	—	7
SMJ 121220	20	305	305	584	483	330	368	391	387	210	60	—	7
SMJ 121221	25D	305	305	559	483	356	395	391	419	187	60	41	7
SMJ 121221	25E	305	305	560	483	356	395	391	419	187	60	79	7
SMJ 121222	25D	305	305	560	483	356	395	391	419	187	60	41	7
SMJ 121222	25E	305	305	560	483	356	395	391	419	187	60	79	7

[1] D = open motor. E = enclosed motor. Horsepowers with no letter suffix are either open or enclosed.

[2] Refer to the base chart on page 4 for base mounting dimensions.

[3] Signifies an N.P.T. threaded outlet. All other blowers have flanged outlets with standard ANSI 125# bolt patterns. All inlets are flanged. Companion flanges are not standard but are available at a nominal cost.

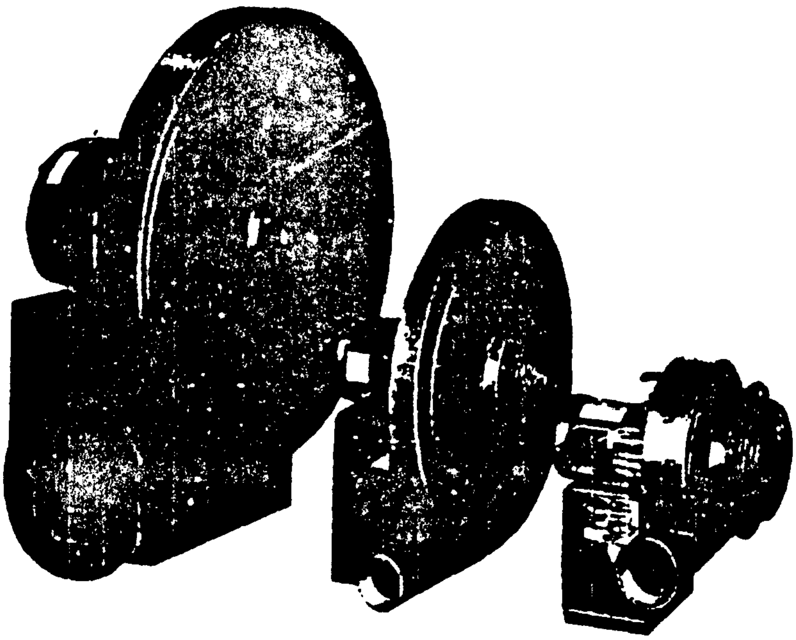
To Order: Specify blower catalog number, CW or CCW rotation, motor HP, open or TEFC, voltage and frame size.

M
578

Info 610
8/89
formerly K-55

ECLIPSE INFORMATION GUIDE

"SMJ" SERIES BLOWERS



1.0 Applications

Eclipse "SMJ" Blowers are centrifugal blowers that provide low pressure air for industrial combustion systems They are also used for cooling, conveying, drying, liquid agitation, smoke abatement, vacuum cleaning, fume and dust exhausting, and other applications where air temperatures are under 220°F.

2.0 Installation

2.1 Blower Installation
Install the blower in an accessible location on a level concrete floor or other substantial mounting platform. The top of the blower base should be level to avoid unnecessary wear on the motor bearings. The blower may be bolted to the platform through the mounting holes provided in the blower base. To prevent vibration which can shorten motor bearing and rotor life, install compressed rubber mounting pads between the blower base and floor.

2.2 Blower Environment
If the blower is mounted in a location where excessive airborne solids are present, use an air filter on the blower inlet or connect the inlet to clean outside air with a pipe no smaller than the blower inlet. Eclipse strongly recommends the use of a combustion air filter suitable for the operating conditions. Blowers can be purchased with filter installed, or filters can be added in the field.

Provide access to the blowers for inspection and maintenance.

2.3 Filter Mounting
To mount a filter in the field, remove the grill from the inlet flange. Align the six holes on the back of the filter housing with the corresponding holes on the inlet flange, as shown in Figure 1 on page 3. Secure the filter housing to the inlet flange with six self-tapping screws.

ECLIPSE COMBUSTION
ROCKFORD, ILLINOIS 61103 (815) 877-3031
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3.0 Piping

3.1 Housing Rotation
SMJ Blowers are available in four different outlet positions. The outlet position that requires the least number of piping bends should be used.

If desired, the outlet position can be changed in the field by disassembling the side plate, rotor, and housing, from base. The housing can then be rotated to the desired outlet position and the blower re-assembled. See Figure 2.

3.2 Minimize Pressure Losses
Air piping should be of ample size, piping runs kept short as possible, and number of bends kept to a minimum in order to avoid excessive pressure losses. As a general rule, when using a blower in a combustion system, keep the air manifold the same size as the blower outlet up to the point of branching off to individual burners. Make sure that all piping is air tight to prevent leakage which causes excessive power consumption.

3.3 Piping Support
Do not use the blower to support the piping. Use independent pipe hangers for this purpose.

3.4 Using Flexible Piping
Use a flexible collar or pipe to connect the blower to the manifold if:

a) The manifold is 30 feet or longer;
b) The manifold is vertical and longer than 15 feet;
c) One blower supplies multiple burners.

3.5 Outlet Flange Specifications
SMJ Blowers are provided with either threaded or flanged outlet, depending on blower size. Flanged outlets are drilled to standard 125# ANSI specifications. Companion flanges are available from Eclipse as optional equipment.

4.0 Electrical Supply

4.1 Check Motor Nameplate
Check the motor nameplate to be sure the motor is correct for the electrical service. Follow the wiring instructions on the motor nameplate. All wiring and fuses must be ample to supply proper voltage and current to the motor. All AC motors should be equipped with a contactor or magnetic starter having thermal overload protection. Check to see that proper heaters are installed in the motor starter.

4.2 Check The Rotor
On initial startup, check to see that the rotor is turning in the correct direction. **If rotation is wrong, reverse wiring.**

5.0 Maintenance

CAUTION

A blower should never be run with both air inlet and outlet wide open. Proper restriction must be located in either inlet or discharge line to avoid overloading and damaging the motor.

5.1 Protect the motor from excessive heat and overload conditions. See the motor nameplate for temperature specifications.

5.2 Clean any accumulation of dirt or dust from the rotor and interior of the blower housing as required. After cleaning, make sure that any remaining dirt does not unbalance the rotor.

5.3 If the rotor fails, carefully check the motor bearings for excessive wear. Worn bearings are usually the cause of rotor failure.

Figure 1–Filter Mounting

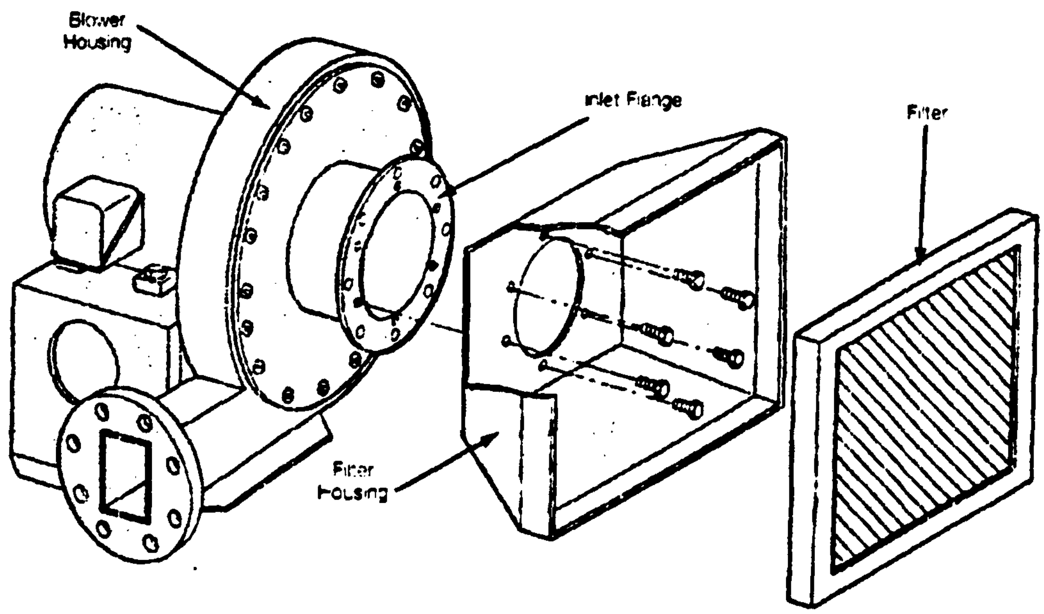
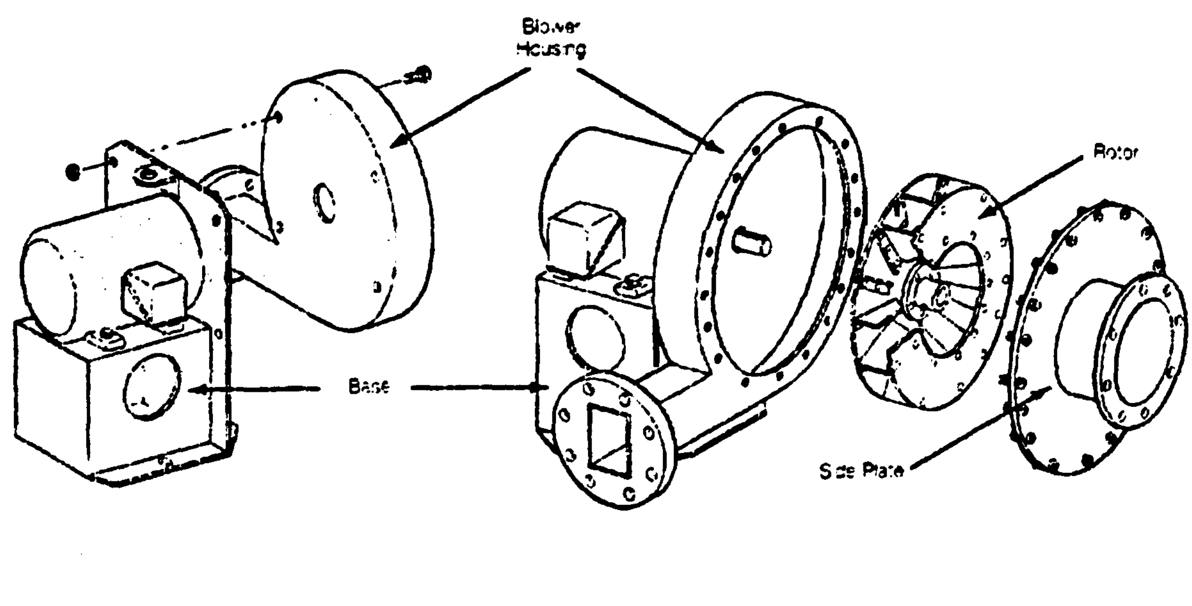


Figure 2–Housing Rotation



Eclipse-Dungs Controls Information Guide

Hydrauli-Matic
Electro-Hydraulic Gas Shutoff Valves

Models MV/6, MVD/6 & MVDLE/6

Warning

- **Do not drop or jar the valve.** Rough handling may damage the valve's internal components and cause unsafe operation.
- **Do not take the valve apart.** If you do, you will void all approvals, listings, and warranties. You may also damage the valve and cause unsafe operation, resulting in a fire or explosion. Return the valve to Eclipse-Dungs for replacement.

1.0 Specifications

Temperature Limits (Ambient)	MV/6 & MVD/6 Series: -20° to +120°F MVDLE/6 Series: -20° to +120°F	
Maximum Working Pressure	MV/6 & MVD/6 Series: 200"w.c. (7 PSI) MVDLE/6 Series: 80"w.c. (3 PSI)	
Gases	UL approved for natural gas, propane, butane, other non-corrosive gases and air. For other gases, contact Eclipse-Dungs.	
Opening Time	MV/6 & MVD/6 Series: Less than one second MVDLE/6 Series: Factory set for 15 to 20 seconds; field adjustment of initial lift will vary that opening time.	
Closing Time	Less than 1 second	
Electrical	Volts/Cycles	120/60 or 24/60
	Opening Current	See Table 1
	Holding Current	See Table 1
	Switching frequency	MV/6 & MVD/6 Series: 1000 per hour MVDLE/6 Series: up to 200 per hour, depending on opening time
Approvals	UL listed & FM approved	
Main Flow Adjustment	Manual (for MVD and MVDLE models only)	

ECLIPSE-DUNGS
CONTROLS L.P.

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Table 1–Opening & Holding Currents

All models are 120 VAC; those marked with an asterisk (*) are also available in 24 VAC models with the same current ratings.

MV Model Number	Req. VA	Opening Current (Amps)	Holding Current (Amps)	MVD Model Number	Req. VA	Opening Current (Amps)	Holding Current (Amps)	MVDLE Model Number	Req. VA	Opening Current (Amps)	Holding Current (Amps)
505/6	15	.08	.08	505/6*	15	.08	.08	205/6*	15	.08	.08
507/6	25	.13	.13	507/6*	25	.13	.13	207/6*	25	.13	.13
510/6	25	.13	.13	510/6*	25	.13	.13	210/6*	25	.13	.13
512/6	60	.26	.26	512/6	60	.26	.26	212/6	60	.26	.26
515/6	60	.26	.26	515/6	60	.26	.26	215/6	60	.26	.26
520/6	100	.48	.48	520/6	100	.48	.48	220/6	60	.26	.26
525/6	80	.42	.42	525/6	80	.42	.42	225/6	100	.42	.42
530/6	100	.50	.50	530/6	100	.50	.50	230/6	80	.50	.50

2.0 Installation

Warning

- **Installation must be done with the supervision of a licensed burner technician. The system must meet all applicable codes. Improper installation may cause explosions, property damage and injuries.**
- **Direct contact between hardening masonry, concrete walls, floors and the solenoid valve is not permissible.**

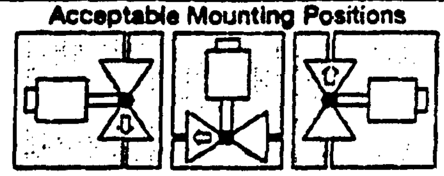
Valve Environment Do not install the valve in anything but an indoor environment.

Mounting Positions **Do not loosen any color-coded screws on the valve body. Disassembling the valve will void all approvals and warranties, and may damage the valve, causing unsafe operation.**

Do not mount the valve in any position other than those shown in the figure at right. Mounting the valve improperly may cause unsafe operation.

Mount the valve so the position indicator on the bottom is clearly visible.

Acceptable Mounting Positions



Pipe Cleaning Before installing the valve, remove pipe scale and other foreign matter that may have accumulated within the connecting pipes.

Piping Support Do not use the valve to support adjacent piping.

Flow Direction Flow of gas through the valve must be in the direction indicated by the arrow on the valve body.

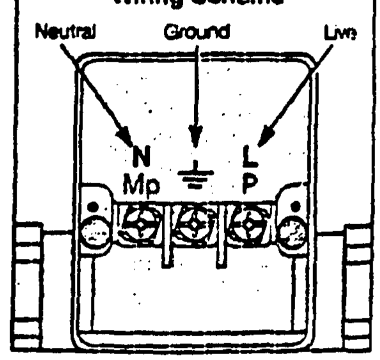
Piping Installation Use the appropriate tools to secure the valve and apply counterpressure when threading pipe into the valve housing.

Use only one of the two available conduit connections.

3.0 Wiring

Wiring Diagram Remove the back cover of the wiring box to expose the three terminals located inside, as illustrated in Figure 1. The left terminal (N) is neutral, the right terminal (L) is line voltage, and the middle terminal is ground.

Figure 1
Wiring Scheme



Electrical Service Be sure to check the nameplate on the valve to make certain electrical ratings correspond with the electrical service being used.

Electrical Code Make all wiring connections to the valve in accordance with local or regional electrical codes.

Wire Ratings Use 14 or 16 gauge wire rated for at least 75°C.

4.0 Maintenance

Warning

- **Do not adjust or remove any screws or bolts which are sealed with a red or blue-colored compound. Doing so will void all approvals and warranties.**

Test Procedure

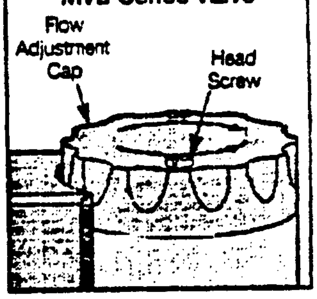
This valve is a protective device. Check it at least once a month for proper operation. Simulate a system interlock failure by cutting off electrical power to the valve. If the valve does not close within one second, immediately shut the system down, remove the valve, and return it to the factory for repair or replacement.

Main Flow Adjustment

MV Series: MV valves are fast opening and fast closing; there is no adjustment for them.

MVD Series: MVD valves are supplied with the main flow adjustment fully open. To adjust the gas flow, refer to Figure 2 while performing the following steps:

Figure 2
MVD Series Valve



1) Located on top of the MVD valve is a flow adjustment cap. There are two screws in the cap; the holding screw is recessed and has blue sealing compound on it, while the head screw protrudes from the cap. Loosen the head screw until you can manually rotate the flow adjustment cap.
2) Following the illustration on top of the cap, turn the cap clockwise for gas flow reduction (–) and counter-clockwise for gas flow increase (+).
3) Check the flame at the gas burner with an orifice or flow meter until you have achieved the desired flow.
4) Tighten the head screw on the flow adjustment cap.

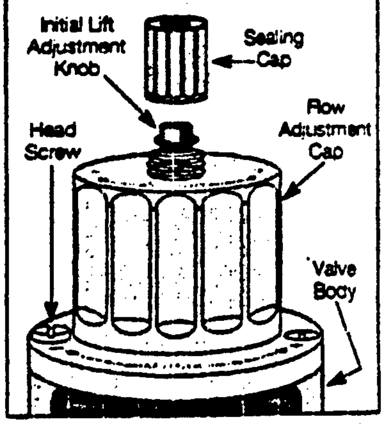
MVDLE Series: MVDLE valves are also supplied with the main flow adjustment fully open. To adjust the gas flow, refer to Figure 3 while performing the following steps:

1) Loosen the head screw until you can manually rotate the flow adjustment cap.
2) While holding the valve body, turn the flow adjustment cap clockwise for less gas (–) or counterclockwise for more gas (+), referring to the "V max." diagram on top of the flow adjustment cap base.
3) Check the flame at the gas burner with an orifice or flow meter until you have achieved the desired flow.
4) Tighten the head screw on the flow adjustment cap.

Initial Lift Adjustment

Initial lift is only a feature found on the MVDLE Series valves. Initial lift adjustment allows the user to vary the initial gas flow and pressure through the valve as the valve seat begins to open. This adjustment can vary the initial gas flow between 0 and 70% of the total gas flow through the valve. Adjusting the initial lift only affects the volume of initial gas flow and has little appreciable effect on the valve's total opening time.

Figure 3
MVDLE Series Valve



All MVDLE valves are shipped from the factory with no initial lift (0%). To adjust the stroke, refer to Figure 3 while performing the following steps:

1) Unscrew the sealing cap to expose the initial lift adjustment knob.
2) The sealing cap also serves as a tool. Turn the cap over and insert into the corresponding slot on the top of the adjustment knob. Turn the knob clockwise (–) for a shorter rapid stroke or counterclockwise for a longer rapid stroke (+), referring to the "V start" diagram on top of the flow adjustment cap.

(Initial lift adjustment instructions continue onto the next page)

4.0 Maintenance (continued)

Initial Lift Adjustment (cont'd)

3) Once the desired initial lift has been achieved, turn the sealing cap back over and reinstall.

Valve Repair or Replacement

Return the valve to Eclipse-Dungs for replacement. Do not try to repair the valve yourself, or you may interfere with the valve's normal operation and cause a fire or explosion.

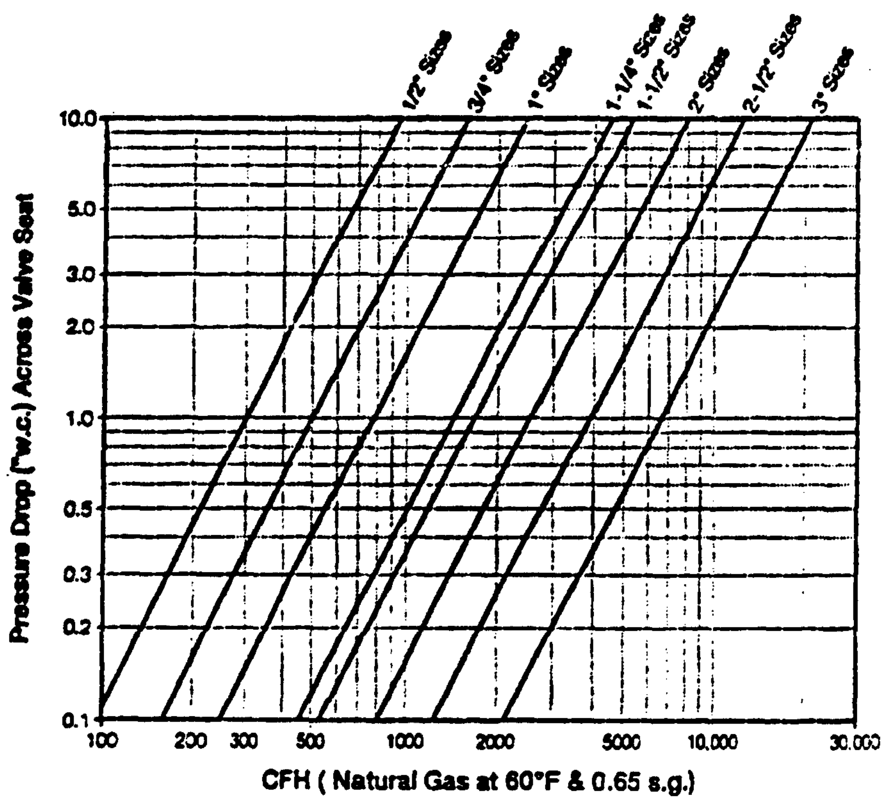
If you disassemble this valve, you will void its FM[redacted] approvals, its UL listing, and the factory warranty and exchange policies.

5.0 Flow Measurement

Figure 4 relates the pressure drop to natural gas flow through the valve.

For greatest accuracy, a straight, uninterrupted run of pipe should extend ten pipe diameters upstream and downstream of the valve.

Figure 4--Flow vs. Pressure Drop



Eclipse-Dungs Controls Information Guide
Visual Indicator for Shut-Off Valves

I-515/525
Supplement
5/93

⚠ Warning

- **The visual indicator is a necessary part of the valve in order to maintain FM approval. The indicator is shipped with, but not attached to, the shutoff valve to insure that the indicator is not damaged during shipment. Therefore, install the indicator onto the valve before the valve is put into service.**
- **The shut-off valve must be de-energized and its gas supply shut off before installing the visual indicator.**
- **DO NOT use the visual indicator on 1/2" size valves!**

1.0 Application

Where It Is Used

The visual indicator is for use with the Eclipse-Dungs MV, MVD, MVDLE and HSAV models of shut-off valves. The indicator screws into the bottom of the valve and visually displays when a valve is in either the open or closed position.

How It Works

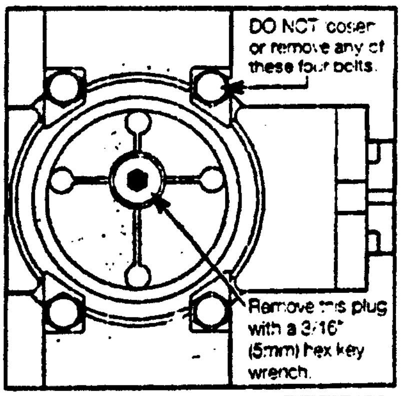
When the shut-off valve is open, the valve operator will observe the red portion of the indicator through the clear plastic. When the valve closes, however, the visual indicator is actuated by the signal bolt of the valve's armature, exposing the white portion of the indicator through the clear plastic.

2.0 Installation

Installing Indicator

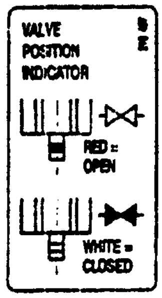
Remove the plug and its O-ring in the bottom of the valve—as illustrated to the right—with a 3/16" (5mm) hex key wrench. This tap is where the visual indicator goes.

Insert the visual indicator and its O-ring: using a 5/8" (16mm) open end wrench, turn clockwise until the visual indicator is sufficiently tightened. DO NOT overtighten or you will destroy the rubber O-ring.



Installing Indicator Sticker

The indicator is also supplied with two adhesive-backed stickers—as illustrated to the right—which show what the colors of the indicator signify. These stickers should be applied (one on each side) of the valve body so the operator can refer to either of them while viewing the indicator. Be certain that the valve area where the stickers will be placed is clean before applying the stickers.



Proper Operation Testing

Before putting the valve into service, test the indicator by opening and closing the valve to visually insure that the indicator is working properly.

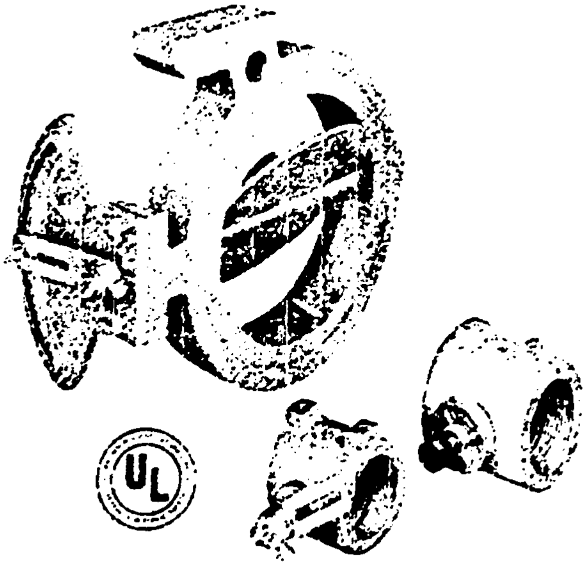
Apply a soap solution between the indicator and the valve body to verify that no leakage occurs.

⚠ Warning

- **A shut-off valve must have at least 5/32" (3.5mm) of stroke for the visual indicator to work properly. This is especially important to remember when adjusting the main flow on MVD and MVDLE models.**

M
558

ECLIPSE BUTTERFLY VALVES
FULL PORT & REDUCED PORT



Eclipse Butterfly Valves are designed to control air and gas flow to all types of combustion systems. They should not be used as tight shut-off valves. Valves are available in 3/4" through 8" sizes for either manual or automatic control and in either full port or reduced port construction. All reduced port valves as well as full port manual valves are furnished with beveled discs and offer 75° rotation. Full port automatic valves are available with beveled discs for 75° rotation or with unbeveled discs which rotate 360°.

Bodies of 3/4" through 4" valves are tapped for standard pipe threads. The 6" and 8" valves are wafer type butterfly valves designed to be sandwiched between flanges on the connecting pipes. Valve bodies are constructed of cast iron. Maximum operating pressure of 3/4" through 4" valves is 5 psig. 6" and 8" valves can be used with pressures to 3 psig.

All butterfly valves feature an easy-to-read indicator plate and a slot on the end of the shaft to provide visual indications of the disc position. Manual butterfly valves 4" and smaller in size are adjusted by a control knob. A locking screw secures the shaft at the desired setting. Manual wafer butterfly valves are adjusted by a control arm which can be locked to the indicating plate by a wing nut.

Automatic butterfly valves are furnished with a control arm. Parts groups for attaching most types of electric or pneumatic operators to Eclipse butterfly valves can be ordered separately. Eclipse also stocks a selection of operators which can be ordered by part number. The shaft length of automatic butterfly valves allows the addition of either a second control arm for simultaneous automatic operation in dual valve applications, or a cam for a low fire microswitch arrangement (page 4).

For control of systems using preheated combustion air, see Bulletins M-160 and M-160-1.

CAPACITIES
FULL PORT

PIPE SIZE	FLOW COEFF. (CV) FULL OPEN	CAPACITY CFH - AIR-INCHES W.C. DROP*									
		0.5"	0.75"	1	1.5"	2"	3"	4"	5"	6"	8"
3/4"	14	425	520	600	730	850	1,030	1,200	1,340	1,480	1,700
1"	46	1,500	1,845	2,130	2,610	3,000	3,690	4,245	4,740	5,190	6,000
1-1/4"	107	3,350	4,130	4,740	5,800	6,700	8,200	9,400	10,500	11,500	13,400
1-1/2"	129	4,000	4,927	5,690	6,960	8,000	9,840	11,320	12,640	13,840	16,000
2"	340	10,600	13,000	15,000	18,300	21,200	26,000	29,700	33,100	36,200	42,400
2-1/2"	435	13,550	16,600	19,200	23,400	27,100	33,000	38,200	42,600	46,600	54,200
3"	695	21,500	26,500	30,700	37,400	43,000	53,000	61,200	68,000	74,400	86,000
4"	1500	47,000	57,000	66,000	81,000	94,000	114,000	132,000	147,000	162,000	183,000
6"	2500	79,800	97,900	113,000	138,400	159,800	195,200	226,000	252,700	276,800	319,700
8"	4200	129,100	158,100	182,600	223,600	258,200	316,400	365,100	408,200	447,200	516,400

REDUCED PORT

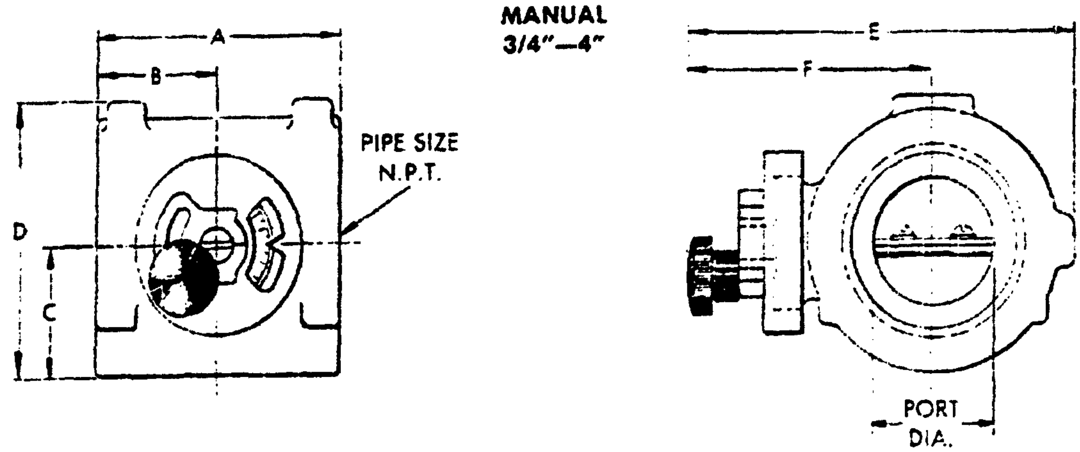
PIPE SIZE	FLOW COEFF. (CV) FULL OPEN	CAPACITY CFH - AIR-INCHES W.C. DROP*									
		0.5"	0.75"	1	1.5"	2"	3"	4"	5"	6"	9"
1"	17.2	410	520	600	725	840	1,025	1,175	1,325	1,450	1,675
1-1/4"	21.5	675	775	900	1,075	1,250	1,525	1,750	1,975	2,150	2,500
1-1/2"	35.2	900	1,100	1,250	1,550	1,800	2,200	2,550	2,850	3,100	3,600
2	57.2	1,800	2,200	2,500	3,100	3,550	4,150	5,000	5,600	6,100	7,000
2-1/2"	82.2	2,600	3,200	3,700	4,500	5,100	6,400	7,400	8,200	9,000	10,500
3	152.5	4,800	5,900	6,800	8,200	9,500	11,500	13,500	15,000	16,500	19,000
4	274.2	8,600	10,700	12,000	15,000	17,000	21,000	24,000	27,000	29,000	34,000
6	553.2	17,000	20,800	24,000	29,400	34,000	41,600	48,000	53,800	58,900	68,000
8	715.5	22,200	27,200	31,400	38,400	44,400	54,300	62,700	70,200	76,900	88,000

*When using gases other than air, Apply multiplier factor to capacities given above.

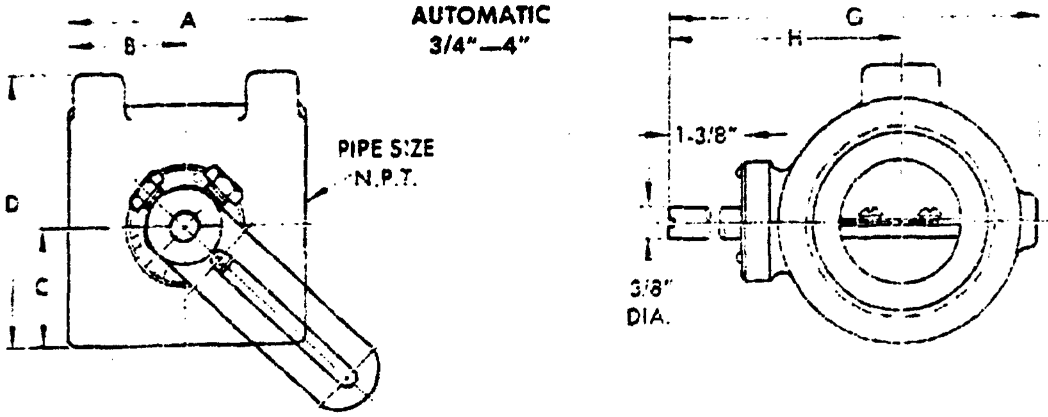
Gas Sp. Gr.	Natural .6	Propane 1.5	Butane 2.0
Multiplier	1.29	.8[illegible]	.70

DIMENSIONS

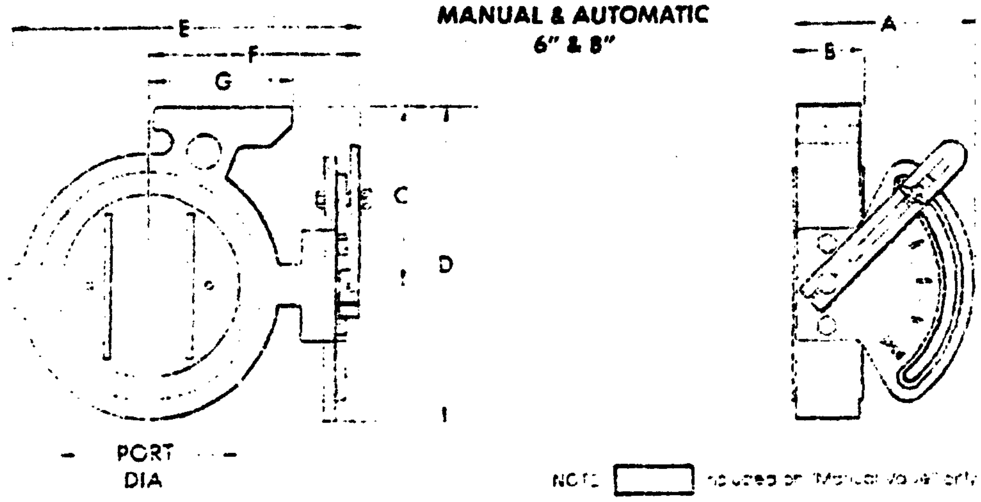
MANUAL 3/4"—4"



AUTOMATIC 3/4"—4"



MANUAL & AUTOMATIC 6" & 8"



NOTE [ ] Included on Manual Valves only

PIPE SIZE N.P.T.	A	B	C	D	E	F	G	H	FULL PORT	REDUCED PORT	APPROX. SHIP WT. IN LBS.
	DIMENSIONS — IN INCHES								PORT DIA. IN INCHES		
3/4	2-7/16	[illegible]	13/16	2	3-5/16	2-5/16	3-13/32	2-19/32	.82[illegible]	—	2
[illegible]	2-7/16	[illegible]	15/16	2-[illegible]	3-5/8	2-1/2	3-29/32	2-25/32	1.140	.8[illegible]	2
1-1/4	3-1/8	1-9/16	1-3/32	2-15/32	3-13/16	2-5/8	4-7/32	2-[illegible]/32	1.43[illegible]	.92[illegible]	2-1/2
1-1/2	3-1/2	[illegible]	1-7/32	2-27/32	4-3/16	[illegible]	4-15/32	2-[illegible]/32	1.71[illegible]	1.1[illegible]	2-3/4
2	3-[illegible]	[illegible]	1-17/32	3-15/32	4-13/16	[illegible]	5-5/32	3-11/32	2.2[illegible]	1.[illegible]	3-3/4
2-1/2	3-7/8	1-15/16	1-7/8	4-1/8	5-7/16	3-7/16	5-23/32	3-23/32	2.5[illegible]	1.72[illegible]	[illegible]
3	[illegible]	[illegible]	2-1/[illegible]	4-5/8	5-15/16	3-[illegible]/16	6-7/32	3-[illegible]/32	3.230	2.2[illegible]	[illegible]
4	5	[illegible]-1/2	2-5/8	[illegible]	7	4-13/16	7-9/32	4-15/32	4.235	2.5[illegible]	[illegible]
6	[illegible]	2-[illegible]	[illegible]	[illegible]	11-3/8	[illegible]-15/16	4-5/8	-	6.[illegible]	4.250	27-1/2
8	[illegible]	[illegible]		[illegible]-15/32	15-[illegible]	[illegible]-1/2	[illegible]		[illegible]	[illegible]	35-1/2

ORDERING INFORMATION

PIPE SIZE N.P.T.	FULL PORT VALVES — MANUAL 75° ROTATION — CATALOG NUMBER	FULL PORT VALVES — MANUAL 75° ROTATION — ASSEMBLY NUMBER	FULL PORT VALVES — AUTOMATIC* 75° ROTATION — CATALOG NUMBER	FULL PORT VALVES — AUTOMATIC* 75° ROTATION — ASSEMBLY NUMBER	FULL PORT VALVES — AUTOMATIC* 360° ROTATION — CATALOG NUMBER	FULL PORT VALVES — AUTOMATIC* 360° ROTATION — ASSEMBLY NUMBER	REDUCED PORT VALVES — MANUAL 75° ROTATION — CATALOG NUMBER	REDUCED PORT VALVES — MANUAL 75° ROTATION — ASSEMBLY NUMBER	REDUCED PORT VALVES — AUTOMATIC* 75° ROTATION — CATALOG NUMBER	REDUCED PORT VALVES — AUTOMATIC* 75° ROTATION — ASSEMBLY NUMBER
3/4	103 BV	50098[illegible]	3 BV-ABC	50056[illegible]	3 BV-A	500917	—	—	—	—
1"	104 BV	500988	4 BV-ABC	500562	4 BV-A	500749	104 BVR	5009[illegible]	4 BV-AR	500920
1-1/4	105 BV	500989	5 BV-ABC	500563	5 BV-A	500750	105 BVR	500961	5 BV-AR	500921
1-1/2"	106 BV	500990	6 BV-ABC	500564	6 BV-A	500751	106 BVR	500962	6 BV-AR	500922
2	108 BV	500991	8 BV-ABC	500565	8 BV-A	500752	108 BVR	500963	8 BV-AR	500923
2-1/2	110 BV	500992	10 BV-ABC	500566	10 BV-A	500753	110 BVR	500964	10 BV-AR	500924
3"	112 BV	500993	12 BV-ABC	500567	12 BV-A	500754	112 BVR	500965	12 BV-AR	500925
4"	116 BV	500994	16 BV-ABC	500568	16 BV-A	500837	116 BVR	500966	16 BV-AR	500926
6	24 BV	500915	24 BV-ABC	500998	—	—	24 BVR	500680	24 BV-AR	500975
8"	32 BV	500913	32 BV-ABC	500999	—	—	32 BVR	500681	32 BV-AR	500976

*Automatic Butterfly Valves are furnished standard with Control Arm Assembly No. 500527. Optional control arm assemblies for 3/8" dia. shafts are listed on page 4 of this bulletin and are available from Eclipse at extra cost. Control arm dimensions are also listed on page 4.

OPERATOR PARTS MOUNTING GROUPS

Parts groups include mounting plates and linkages. They do not include valve, operator, or operator control arm. Parts groups will fit any size valve.

500928

500756

500843

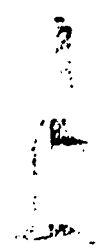
500798

FOR ELECTRIC OPERATORS

PARTS GROUP ASSY. NO.	OPERATOR TO BE MOUNTED
500928	Eclipse, Penn, Barber-Colman, L & N 10210 Series, Honeywell M451, M644, M941, M934, M941A, M644, M904, M94[illegible], [illegible] M805, M7044, M7045, and all other "Modutrol" motors
500756	Honeywell M640 & M940
500843	L & N 10250 Series
500798	White-Rodgers Type 2405-[illegible]

500784

500995



5009[illegible]

FOR PNEUMATIC OPERATORS

PARTS GROUP ASSY. NO.	OPERATOR TO BE MOUNTED
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

OPERATOR MOUNTING PLATES/BRACKETS

Part Number 13095 fits most Honeywell, Barber-Colman, Penn, and L&N 10211 through 10218 electric control motors.

Assembly Number 500228 is a mounting bracket for Barber-Colman pneumatic, thrust model operators.

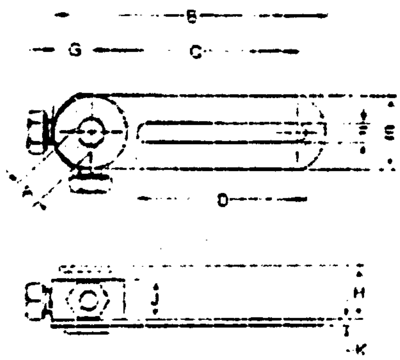
Part Number 12758 mounts on Part Number 13095 for installation of either a Honeywell model M630 or M930 "Actionator" control motor.

Part Number 10689 is for mounting the Honeywell lever type pneumatic operator. It also accommodates Fischer 658 operator.

Part Number 10869-1 is for L&N control motor series 10260 through 10268 (electrically operated).

Part Number 03394 is for the Honeywell thrust model actuator.

BUTTERFLY VALVE CONTROL ARMS



ASSY. NO	A	B	C	D	E	F	G	H	J	K
500527*	3/8	3-3/4	2-7/8"	2-3/8"	1"	9/32	9/16	11/16	9/16"	1/8"
500526†										
5005[illegible]††	3/8	4-13/16"	3-7/8"	2-3/4"	1-1/8"					
5005[illegible]††	1/2									
5005[illegible]††	5/8									
5005[illegible]††	3/8	5-9/16	4-5/8							
5005[illegible]††	1/2"									
5005[illegible]**	5/8									
5005[illegible]	1/2	6	4-7/8"	2"	1-1/2"	3/8"	3/4"	—	1"	1/4"
500541-2	5/8"									
500541-3	3/4"									

* Control Arm Assembly No. 500527 is furnished standard on all Basic Automatic Butterfly Valves. Other sizes are optional at extra cost.

† Control Arm Assembly No. 500526 is dimensionally the same as 500527 but has a pointer to indicate relative shutoff position.

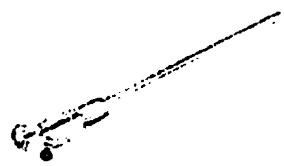
** These sizes have extended hub indicated by dotted lines on drawing, for use with pointer.

LINKAGE CONTROL RODS

Zinc-Plated Cold-Rolled Steel.

DIA.	PART NO.	LENGTH
5/16"	2750	8
	12750-1	1[illegible]
	12750-2	18"
	12750-3	24"
	12750-5	[illegible]

DIA.	PART NO.	LENGTH
1/2"	10175-1	12
	10175-2	15
	10175-3	18
	10175-4	24"
	10175-5	30"
	10175-6	36"
	10175-7	48"
	10175-8	60"
	10175-9	72"



Assembly Number 500978 is for use on Lever Type Pneumatic Operators. The rod is zinc-plated cold-rolled steel. Shoulder screw is Part Number 14241; locknut is Part Number 13892.

SWIVEL CONNECTORS

FOR 5/16" DIA. CONTROL RODS

Assembly Number 500558 is a rotating swivel block connector for joining control rod to control arm. It allows 360° rotation

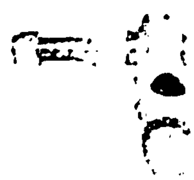
Assembly Number 500569 serves to connect two control rods to one control arm and also allows 360° rotation.

Part Number 14316 swivel connector allows 360° rotation. It provides a 20° flex from the swivel center line to accommodate an angular approach of a linkage control rod, but immediacy of response is less positive than Part Number 14264 (at right).

Part Number 14264 is a non-flexing swivel connector that allows 360° rotation around swivel center line. It provides a more positive positioning and immediacy of response than Part Number 14316 (at left).

FOR 1/2" DIA. CONTROL RODS

Swivel block, Assembly Number 500542, rotates 360°.

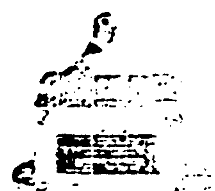


Single ball swivel. Assembly Number 500543 permits angular approach of rod toward control arm Rotates 360°.

Double ball swivel. Assembly Number 500544, connects two rods to one control arm. Allows angular approach of rod to arm, rotates 360°.

CAM & MICRO SWITCH

Brass cam for butterfly valve shaft. Part Number 01631-1 fits 3/8" shaft; part number 01632-1 fits 1/2" shaft



The micro switch is a CON item for use with cam to prove low fire in combustion system.

OPERATORS FOR AUTOMATIC BUTTERFLY VALVES

CONTROL MOTORS

Model	Eclipse Part Number	Stroke, Degrees	Timing, Seconds	Torque, Lb.-In.	Volts	Crank Arm Part Number	Crank Arm Included w/Motor
Two Position							
Eclipse							
EMA-405	12616	180	20	16	120	12665	Yes
Honeywell							
M644A-1024	10826	90	30	150	24	18093	No
White Rodgers[1]							
3405-3	16058	90	40	20	24	3/8"[5]	No
Proportioning with Slidewire Feedback							
Eclipse							
EMP-423-1[2]	12618	90	12	60	120	12666	Yes
EMP-424-1[2]	12622	90	12[3]	60	120	12666	Yes
EMP-453-1[2]	12632	90	40	220	120	12656	Yes
EMP-454-1[2]	12634	90	40[3]	220	120	12666	Yes
Honeywell							
M941B-1007	17997	160[4]	60[4]	150	24	18093	No
Penn							
M80JAA-3	13154	90[4]	30	80	24	18270	No
Potentiometer Positioned Proportioning							
Eclipse							
EMP-423-2	12640	90	12	60	120	12666	Yes
EMP-424-2	12642	90	12[3]	60	120	12666	Yes
EMP-453-2	12646	90	40	220	120	12666	Yes
EMP-454-2	1265[illegible]	90	40[3]	220	120	12666	Yes
Honeywell							
M941A-1024	16107	160[7]	120[7]	150	24	18093	No
M941A-1057	15433	90[6]	15[8]	75	24	18093	No
Current to Position Proportioning, 4-20 mA Input							
Eclipse							
EMP-423-3	12652	90	12	60	120	12666	Yes
EMP-424-3	12653	90	12[3]	60	120	12666	Yes
EMP-453-3	12656	90	40	220	120	12666	Yes
EMP-454-3	12655	90	40[3]	220	120	12666	Yes
Honeywell							
M744S-1005	12200	90	30	150	120	18093	No

[1]Double ended shaft. Must be mounted with shaft horizontal
[2]Can be used as two position if internal slidewire is not connected.
[3]Adjustable timing. Maximum is approximately ten times the minimum shown.
[4]Adjustable stroke, built-in position indicator. Solid state drive.
[5]See 3/8" BV control arms, page 4.
[6]Field adjustable to 90° stroke, 30 seconds, 150 lb.-in.
[7]Field adjustable to 90° stroke, 60 seconds, 150 lb.-in.
[8]Field adjustable to 160° stroke, 30 seconds, 75 lb.-in.

MOTOR ACCESSORIES

ITEM	DESCRIPTION
16921	120 to 24V. transformer for Penn, Honeywell, or White Rodgers Motors. Plate mounted, fits 4 x 4 electrical junction box.
14892	120 to 24V. transformer, Honeywell motors only. Mounts in place of standard motor cover.
12674	Auxiliary slidewire kit, Eclipse motors only.
12670	Auxiliary switch kit, Eclipse motors only.
12676	Weather resistant cover, Eclipse motors only
12677	Paralleling relay, Eclipse motors only.
12707	35 ohm slidewire. Eclipse motors only.

PNEUMATIC ACTUATORS

LEVER ACTUATED MODELS

12476—Honeywell 863T-1-G-0-1 Short Lever Model Air-O-Motor, Type 03. With positioner, direct acting. Supply air pressure 18 to 25 psig for 3 to 15 psig instrument air. Maximum stroke from 3-1/4" to 4-5/16", depending on lever pivot point used.

12851—Honeywell 8610314-108 Short Lever Model Air-O-Motor, Type 03. Less positioner. For 3 to 15 psig instrument air. Maximum stroke from 3-1/4" to 4-5/16", depending on lever pivot point used.

THRUST MODELS

11139—Honeywell 8610314-112 Thrust Model Air-O-Motor, Type 03. Less positioner, direct acting. For 3 to 15 psig instrument air. 1-1/2" stroke. This operator has limited application because of the short stroke. For greater stroke, use 13114.

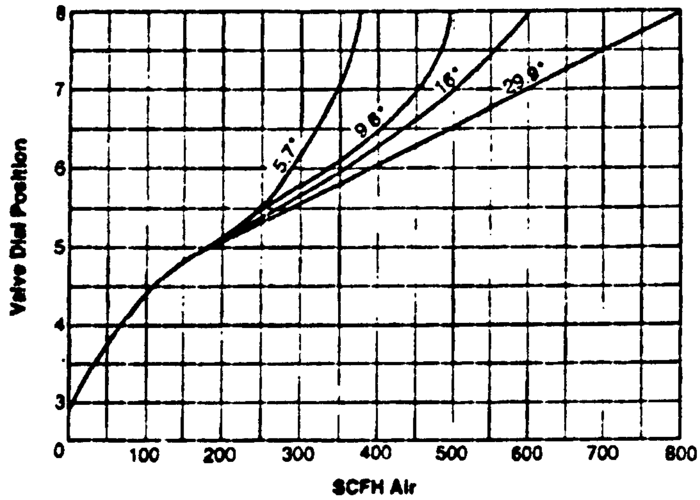
13114—Barber-Colman Model MK3141. 3 to 15 psig range with 4" stroke; 3 to 13 psig range with 3-1/2" stroke. Minimum stroke 2". A positive action pneumatic relay can be supplied for this operator on special order.

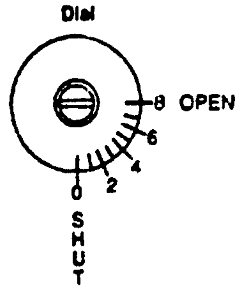
HIGH PRESSURE DROP
BUTTERFLY VALVES

Eclipse high pressure drop butterfly valves offer close flow control throughout the range of shaft rotation. They can provide smooth, stable control of combustion systems designed for modulation of gas flow only, such as air heat systems, excess air systems, and many tube firing systems.

CAPACITY

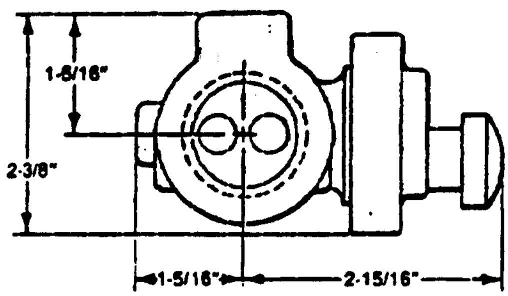
"Indicates "w.c. drop across valve

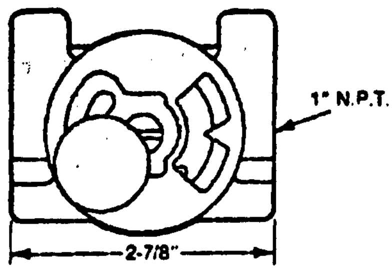




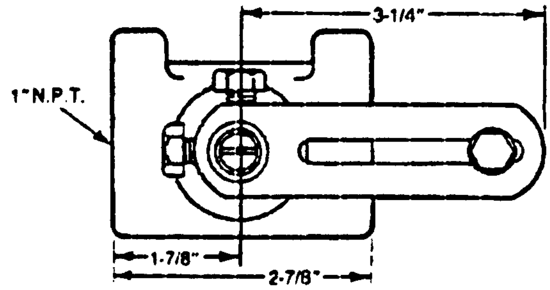
DIMENSIONS

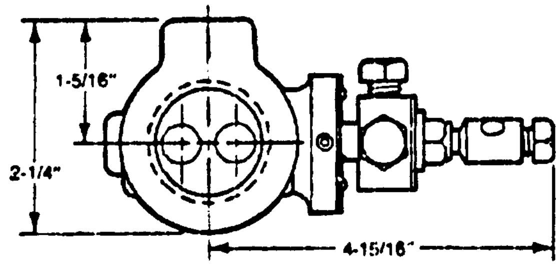
MANUAL—404 BV
Assembly No. 500377





AUTOMATIC—404 BVA
Assembly No. 500378



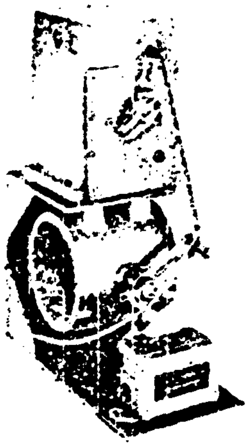


DUAL BUTTERFLY VALVE & LOW FIRE CAM/MICRO SWITCH ASSEMBLIES

All Eclipse Butterfly Valves, with the exception of the manual models, are manufactured with extended shutter shafts as standard equipment in order to accommodate an additional control arm for dual valve or low fire cam/micro switch requirements in combustion systems. The photos on this page are representative of common arrangements available, furnished completely assembled, if so ordered, from the Eclipse factory.

The assembly brackets are special order items based on valve sizes selected and specific piping requirements.

This dual valve arrangement can accommodate either pneumatic or electric operators. It may be ordered with or less operator, assembled or disassembled, and comes complete with butterfly valves (as specified by customer), mounting bracket and linkage assembly (except for operator control arm if ordered less operator).



For electric operation, this arrangement is designed to prove low fire in combustion systems and may be ordered complete as shown here, less operator and operator control arm, or disassembled.

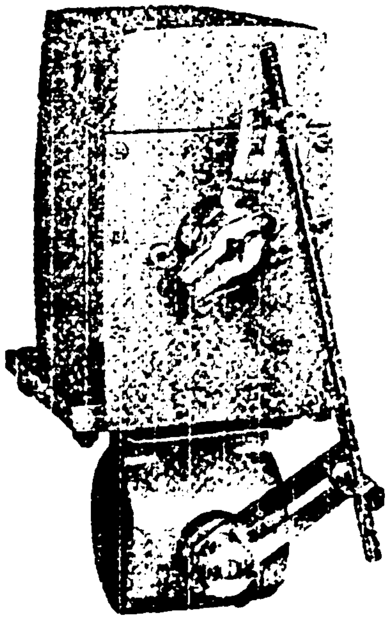
This cam/microswitch set-up is assembled for pneumatic (thrust type) operation and is also for proving low fire in combustion systems. It, too, may be ordered as shown here, less operator, or disassembled

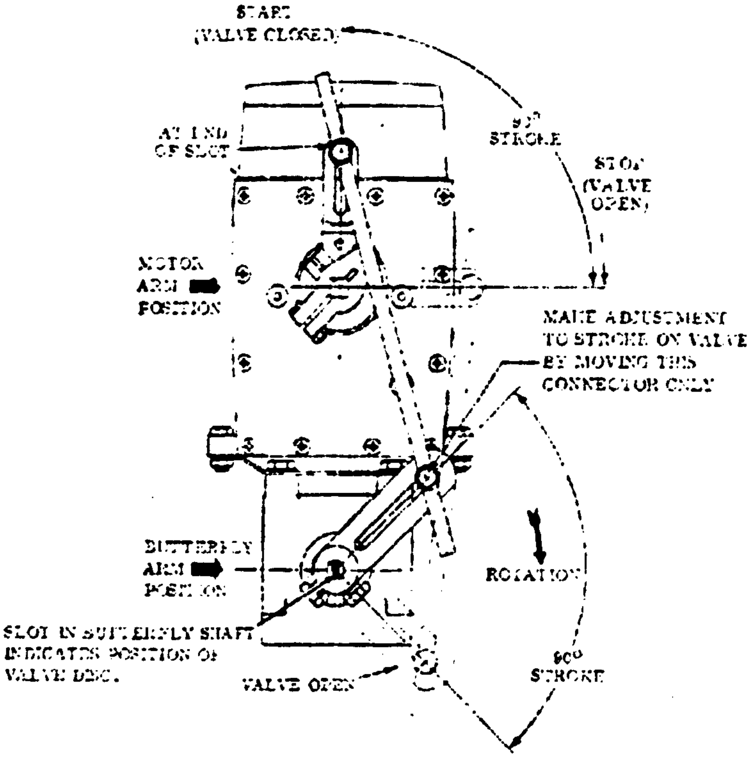
Valve control arm/linkage set-up differs from the dual valve arrangement in that it does not utilize the double block swivel connector, but instead, has an additional control arm on the top valve shaft. This arrangement, too, may be ordered as shown, less operator and operator control arm, or disassembled.

M
621

Info 720
10/78
formerly M-150

ECLIPSE INFORMATION GUIDE
LINKAGE ADJUSTMENT FOR AUTOMATIC BUTTERFLY VALVES WITH 90° MOTOR OPERATOR





1. Crank arm on motor is vertical for start of stroke.

2. Make all adjustments to linkage with motor in low fire position. Never adjust linkage when motor is in any other position. Care must be taken to prevent the linkage from binding and stalling the motor.

3. Swivel connector should be near end of motor arm on initial adjustment. Change stroke on valve arm connector only.

4. Slot on Butterfly Valve shaft indicates valve position.

5. Adjust butterfly valve to be closed at beginning of stroke. Customer must adjust the minimum opening of butterfly at jobsite for the required low flow condition.

6. Stroke of butterfly crank arm shall be adjusted to provide 85° normal full opening to a maximum of 90° opening of butterfly valve. 85° opening is preferred to prevent binding of the linkage. The last 5° of rotation produces very little change of flow.

7. DO NOT exceed 90° stroke on butterfly valve as the valve begins closing again as the rotation exceeds 90° stroke.

8. 90° stroke drive motors must be used on all butterfly valves.

9. When supplied from the Eclipse factory mounted to the butterfly valve, Honeywell and Penn Motors are adjusted to 90° stroke. When supplied separately, or from the manufacturer, motors must be checked by the customer and adjusted, if necessary, for 90° stroke.

ECLIPSE COMBUSTION

ECLIPSE INFORMATION GUIDE
WAFER BUTTERFLY VALVES

MANUAL

AUTOMATIC

Eclipse Wafer Butterfly Valves are designed to provide manual or automatic control of low pressure air. Both full and reduced port models are available in 6" and 8" pipe sizes. These valves are designed to be used in conjunction with 125# or 150# ASA flanges. Eclipse Wafer Butterfly Valves can withstand static line pressures up to 50 psig and temperatures from -30° F. to 125° F.

Components which will contact the air stream are constructed of the following materials: Body, cast iron; Butterfly, aluminum; Shaft, chrome treated steel; Shaft seal, Buna N.

1.0 INSTALLATION

1.1 The valve may be installed in either vertical or horizontal pipe lines.

1.2 Wafer valves are not tight shut-off, therefore, if tight shut-off is required, the wafer valve must be preceded by a manual or automatic tight shut-off valve.

1.3 Install companion flanges on the piping properly spaced to hold the valve body. Put standard flange gaskets between the companion flanges and the valve body and tighten bolts.

1.4 In cases where there are extended pipe runs, support the piping by suitable pipe hangers to avoid strain on the valve connections.

2.0 OPERATION

2.1 Maximum operating pressure differential is not to exceed 3 psig.

2.2 For manual control of Eclipse Wafer Valves, loosen the wing nut on the control arm and move the control arm to the desired position.

2.3 Valve disc position is indicated by the slot in the end of the shaft extension.

2.4 On manual valves, once the control arm has been moved to the desired opening position, tighten the wing nut.

3.0 MAINTENANCE

3.1 These valves should be lubricated yearly.

3.1.1 A grease fitting is supplied at the shaft end of the valve body.

3.1.2 A pipe plug at the opposite end of the shaft can be removed and the opening packed with grease.

M
643 **Honeywell**

UDC 3000/UDC 5000/UDC 6000
Universal Digital Controllers
RS422/485 Communications Option

Product Manual

51-51-25-35C

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Honeywell
Industrial Automation and Control
Automation College
100 Virginia Drive
Fort Washington, PA 19034

(215) 641-3126

About This Publication

The UDC manual for RS422/485 communications option contains the following sections:

Communication between your computer and the UDC Controller is accomplished for one piece of information (parameter) at a time. Each parameter has an associated identifying code.

The Identifying Code and Format Code will be listed along with information pertaining to that parameter.

The identifying codes are grouped in the same order as they appear in the controller configuration prompts.

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Tables

Parameters

COM STATE	Communication State
ADDRESS	Communication Address (Loop 1)
ADDRESS 2	Communication Address (Loop 2)
SHED TIME	Shed Time
PARITY	Parity
BAUD RATE	Baud Rate (bits/second)
SHED MODE	Controller Shed Mode and Output Level
SHED SP	Shed Setpoint Recall
UNITS	Communication Units
CSP RATIO	Commun. SP Ratio (Loop 1)
CSP BIAS	Commun. SP Bias (Loop 1)
CSP2 RATIO	Commun. SP Ratio (Loop 2)
CSP2 BIAS	Commun. SP Bias (Loop 2)

References

Publication Title	Publication Number
UDC 3000 Product Manual	51-52-25-07
UDC 3000 Limit Controller Product Manual	51-52-25-09
UDC 5000 Product Manual	51-51-25-17
UDC 6000 Product Manual	51-52-25-32

Section 1 – Overview

Introduction

The communications option

The RS422/485 Communications Option on the UDC Controller provides a serial multi-drop link whereby up to fifteen UDC controllers connect directly to a host computer.

Monitor or slave mode

The UDC controller can be placed in monitor or slave by the host computer. When monitored, the controller will send Configuration, Tuning, and Operating parameters to the host computer. When in slave, the controller will be switched through the communications interface board to "Slave" operation. This means that the computer can write configuration or tuning information into any controller on the link including overriding of PV, the setpoint, and output.

Message exchanges

The computer and the controllers talk to each other through a series of message exchanges. There are two RS422/485 message exchange protocols: Configuration or Loopback.

Message Exchange Protocols

Configuration protocol

Table 1-1 lists the rules and regulations of configuration protocol.

Table 1-1 Rules and Regulations for Configuration Protocol

Protocol	Rule
Data Type Transactions	The configuration protocol permits reading or writing of data type transactions such as PV, SP, or Output, as well as configuration type transactions such as Tuning Algorithm selections, etc.
Read	Read transactions can be performed in either UDC state: Monitor or Slave.
Write	Write transactions can only be performed in the Slave mode.
Busy	Following any Write message, a Busy indication is returned.
Ready	A Ready transaction is required as the next message request to determine if the information received was correct.
Transaction Limits	In a Write transaction, only single items are permitted to be written, however, for Read transactions, single or multi-item parameters may be requested.

Loopback

Loopback protocol is also provided for link tests. With this message exchange you can test the Communications link between your computer and the controllers on the link. The host computer sends a series of ASCII characters to the desired device, and the device returns the characters it received to the host computer.

Checksum

There is an optional transaction called "Checksum" which is used to increase security on the RS422/485 link. Used with any message exchange, it enables both your computer and controller to detect messages that have been interrupted by line noise.

Each controller will have its own specific address. If you have a 2 loop controller there will be a specific address for each loop.

Address, Baud Rate, and Parity are keyboard selectable as well as Shed Time, Shed Mode, and Output Level.

Field Upgrade

Adding the communications option

RS422/485 Communications Option can be added in the field by installing the proper RS422/485 Printed Wiring Assembly.

Table 1-2 lists the part numbers required to add the communication option to the UDC controllers.

Table 1-2 Upgrade Part Numbers

Model	Upgrade Part Numbers
UDC 3000	Part Number 30756693-501
UDC 5000	Part Number 30755865-502 includes PROM 30755949-401 (32 Pin)
UDC 6000	Part Number 30755865-501 includes PROM 30755949-401 (32 Pin)

ATTENTION

Early version UDC 5000 with 28 Pin PROM cannot be upgraded to RS422/485 unless the PROM socket has 32 Pin receptacles.

Section 2 – Installation

Introduction

General

The Installation section (section 2) of the UDC Product Manual contains information and drawings required to mount and wire the controller. Refer to the Controller Product Manual for appropriate information regarding the basic installation requirements.

What's in this section

This section contains the following information:

Continued on next page

Electrical noise protection

When installing and wiring the controller, follow the practices that conform to all local codes and ordinances. In addition, be aware of the precautions you should take to avoid electrical noise.

Electrical noise is unwanted electrical signals that provide undesirable effects. Digital equipment is especially sensitive to the effects of electrical noise. The controller has built-in circuits to reduce the effects of this noise.

For information concerning further reduction of electrical noise, refer to "How to Apply Digital Instrumentation in Severe Electrical Noise Environments" – in the UDC Product Manual.

Connecting the RS422/485 link

A UDC controller with RS422/485 Communications option can be connected to your computer using one of two arrangements shown in Table 2-1.

Table 2-1 Connection Arrangements

Arrangement	Description
ICS plug-in I/O board	Wired directly to the RS422/485 port in your computer using an ICS plug-in I/O board which is specifically designed to interface with the IBM (or IBM compatible) PC, PC/XT, or PC/AT computer. This board is available from . . . ICS Computer Products, Inc. 5466 Complex Street Suite 208 San Diego, California 92123
Burr/Brown Converter	Using the RS232 port and a Burr-Brown RS232 to RS422/485 converter installed between the RS232 port and the UDC controller This converter is available from . . . Burr-Brown International Airport Industrial Park P.O. Box 11400 Tucson, Arizona 85734 Part number LDM485ST, limited distance modem

Wiring the RS422/485 Port

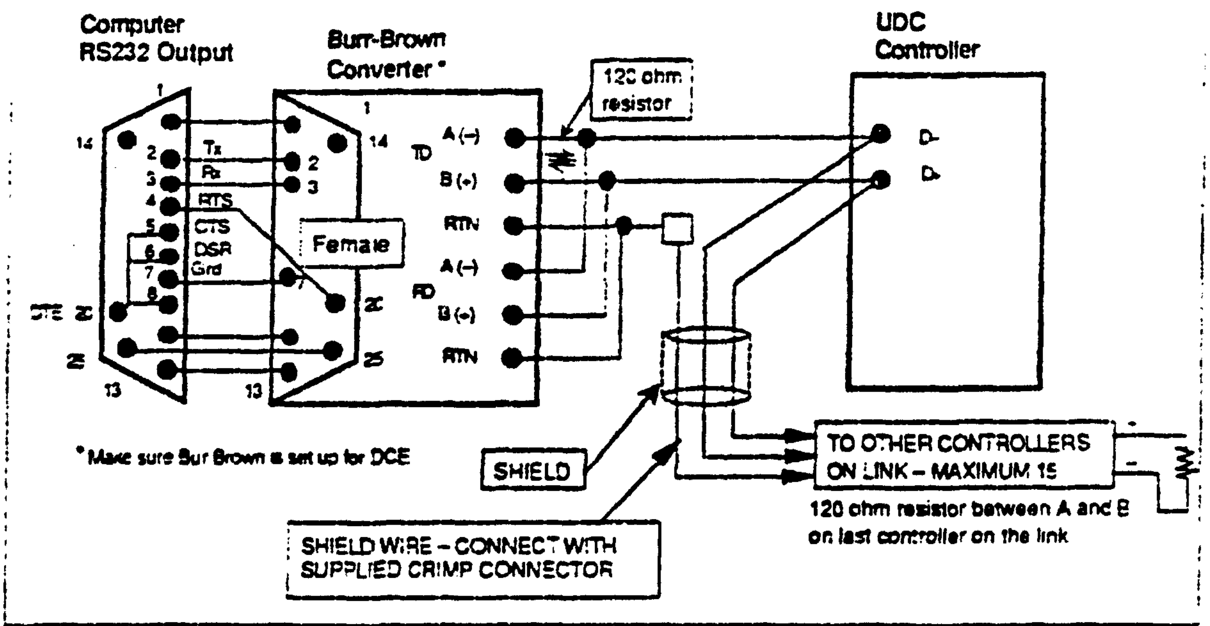
Terminal connections

Connect the PC to the Honeywell Link. Figure 2-1 below shows the wiring diagram and terminal connections for wiring the RS422/485 port. Follow the procedure in Table 2-2 to wire the RS422/485 port.

Table 2-2 RS422/485 Port Wiring Connections Procedure

Step	Action
1	Connect the shield to pin 7.
2	Connect one wire to pin 13 (TX-/RX-).
3	Connect other wire to 12 (TX+/RX+)
4	Install a 120 ohm resistor across TX-/RX- and TX+/RX+.

Figure 2-1 Wiring the RS422/485 Port



Continued on next page

Wiring the RS422/485 Port, Continued

Jumper locations

Refer to the ICS RS422/485 Serial Interface User's Manual and jumper the locations listed in Table 2-3.

Table 2-3 RS422/485 Port Jumpers Locations

Jumper Location	If you are using COM1	COM2	COM3	Enable Disable
Base Address Selection	A9	A9	A9	Enable
	A8			
	A7	A7	A7	
	A6	A6	A6	
	A5	A5	A5	
	A4	A4		
	A3	A3	A3	
Interrupt Selection	IN4	IN3	IN2	Enable
Mode Selection	HDX	HDX	HDX	Enable
	SX	SX	SX	
	FDX	RDX	RDX	Disable
	DX	DX	DX	
RTS Load Control	RTS	RTS	RTS	Enable
	LD	LD	LD	Disable
Slot S				Disable

Technical Considerations for the RS422/485 Port Wiring

Implementing RTS

The Request-to-Send signal prepares the interface card to properly manipulate the multi-drop link. You must program RTS "True" when your computer sends the controller a request and "False" at other times. This allows the controller to transmit data to your computer whenever your computer is not transmitting to the controller. If you fail to program this signal "False" the controller will be unable to return response messages to your computer.

ASCII code set

The controller responds to 8-bit characters which comply with the 64-character implementation of the American Standard Code for Information Interchange (ASCII). The controller responds only to:

- upper case, alphabetic characters (A-F),
- numeric characters (0-9),
- certain symbols such as comma (,), period (.) used as a decimal point, and hyphen (-) used as a minus sign.
- certain commands such as carriage return and Line Feed.

Parity

Transmitting each ASCII character requires 8 bits:

- 7 bits for the character code,
- 1 bit (the eighth) for parity, which may represent either odd or even parity.

The UDC can transmit and receive data using either odd or even parity. The UDC performs parity checks on your computer's data transmissions. The controller returns STATUS CODE 04 if it detects incorrect parity.

Wiring the Burr-Brown Converter

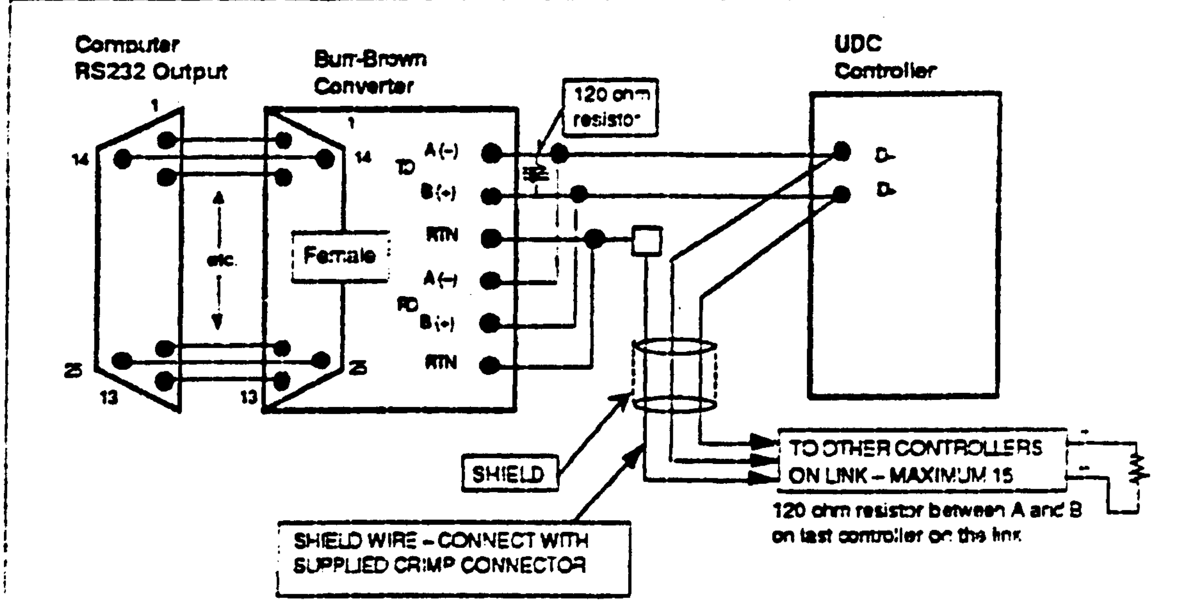
Terminal connections

Figure 2-4 shows the wiring diagram and terminal connections for wiring the RS232/RS422 Burr-Brown converter. Follow the procedure in Table 2-4 to wire the Burr-Brown converter.

Table 2-4 Burr-Brown Converter Wiring Connections Procedure

Step	Action
1	Install an appropriate Serial Communication Connector between the Computer serial port and the RS232 input connector of the Burr Brown converter. See the Burr Brown data shed for the required interfacing signals
2	Connect the shield to pin RTN.
3	Connect one wire to pin A(−).
4	Connect other wire to pin B(+).
5	Connect a 120 ohm resistor across A and B.

Figure 2-2 Burr-Brown Converter Wiring Connections



Technical Considerations for the Burr-Brown Converter Wiring

Implementing DTR

The Data-Terminal-Ready signal prepares the Burr-Brown converter to properly manipulate the multi-drop link.

You must program DTR "True" when your computer sends the controller a request and "False" at other times. This allows the controller to transmit data to your computer whenever your computer is not transmitting to the controller. If you fail to program this signal "False" the controller will be unable to return response messages to your computer.

ASCII code set

The controller responds to 8-bit characters which comply with the 64-character implementation of the American Standard Code for Information Interchange (ASCII). The controller responds only to:

- upper case, alphabetic characters (A-F), for hexadecimal values,
- numeric characters (0-9),
- certain symbols such as comma (,), period (.) used as a decimal point, and hyphen (-) used as a minus sign,
- certain commands such as carriage return and Line Feed.

Parity

Transmitting each ASCII character requires 8 bits:

- 7 bits for the character code,
- 1 bit (the eighth) for parity, which may represent either odd or even parity.

The UDC can transmit and receive data using either odd or even parity. The UDC performs parity checks on your computer's data transmissions. The controller returns STATUS CODE 04 if it detects incorrect parity.

Wiring the RS422/485 Link

Communications link connections

Figure 2-3 shows the Honeywell communications link connecting a personal computer to a maximum of 15 UDCs. Follow the procedure in Table 2-5 to wire the RS422/485 Communications Link.

Table 2-5 RS422/485 Link Wiring Procedure

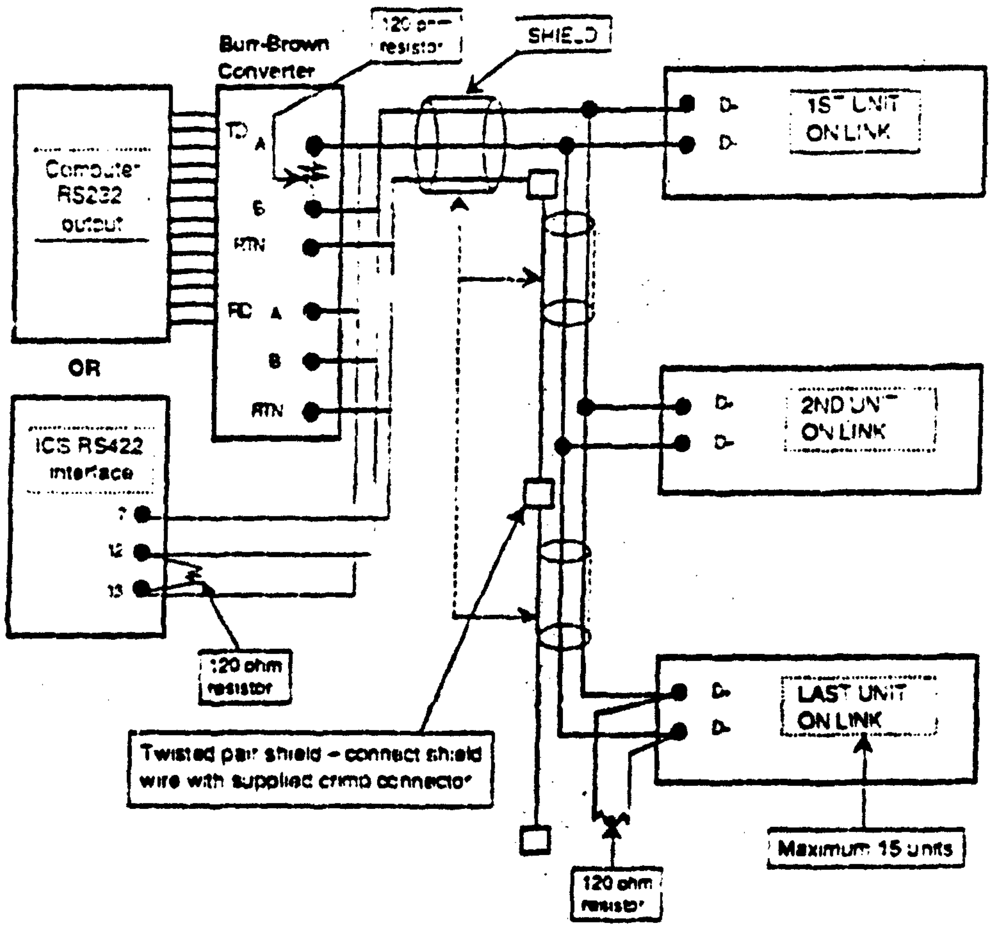
Step	Action
1	Create a chain of up to 15 UDCs by connecting them with shielded twisted pair wiring (Belden 9271 Twinax or equivalent) to a maximum total length of 4000 feet (see Section 10—Cable Specifications;
2	Connect the shields together with the crimp connector supplied
3	Connect the negative wires to D–. See proper device wiring diagram for terminal number.
4	Connect the positive wires to D+. See proper device wiring diagram for terminal number
5	Install a 120 ohm resistor across screw terminals D+ and D– on the last UDC on the link.
6	Make sure resistors are installed at the computer depending on the port being used: • RS422 I/O Card (pins 12 and 13) • Burr-Brown Converter (A and B)

Continued on next page

Wiring the RS422/485 Link, Continued

Communications link connections, continued

Figure 2-3 RS422/485 Link Wiring Connections



Section 3 – Establishing Communications and Testing

Preparing the Controller for Communications

Introduction

Each controller on the RS422/485 Communications link must be configured at the controller level for certain parameters before communications between the Host and the Controller can be accomplished.

Synchronization

Before you attempt to exchange messages between your computer and the controllers on the RS422/485 link, you must set up the controller for the same form of data transmission that the host computer's RS422/485 interface uses. This is called Synchronization.

You must match the controller Baud Rate and Parity with that of your computer.

Configurable parameters

Table 3-1 is a list of parameters that should be configured, their definitions, range of settings or selections, the procedure for entering the information into the controller is found in Table 3-2.

Table 3-1 Communications Parameters

Parameter	Definition
Communications State	Enables or disables the Communication function in the controller.
Communications Address	This is a number that is assigned to a controller (limited to 15 controllers) that will be used during communications. This number will be its address on the link (address 0-99). If your controller has two loops, each loop must have its own individual address (i.e. Loop 1, #6; Loop 2, #7).
Shed	Term used to describe a point in time when the controller, which had been working as a slave, reverts to an independent, stand alone controller using its own inputs, configuration data and control mode. Shed will happen when a controller is in slave, the shed is not zero, and the communication stops.
Shed Time	The number selected will represent how many sample periods will elapse before the controller sheds from computer control. Each period equals 1/3 second. 0 = No shed.

Continued on next page

Preparing the Controller for Communications, Continued

Parameters, continued

Table 3-1 Communications Parameters, Continued

Parameter	Definition
Shed Controller Mode and Output Level	This selection determines the mode of local control whenever the controller is SHED from the slave mode. • Last Mode and Output – The controller will return to the same mode (Manual or Automatic) and Output level that it was in before shed. • Manual Mode, Last Output – The controller will return to manual mode and the last output level it was in before shed • Manual Mode, Failsafe Output – The controller will return to manual mode at the output level selected at ID code 40 – Failsafe Output Value. • Shed to Automatic Mode – The controller will return to automatic mode.
Shed Setpoint Recall	This selection determines what setpoint will be used if the controller is shed from the communications link. • TO LSP – The controller will use the last local setpoint stored. • TO CSP – The controller will store the last computer setpoint and use it at the Local Setpoint (LSP1, LSP2, or LSP3, whichever is in use).
Parity	Transmitting each ASCII character requires 8 bits. • 7 bits for the character code • 1 bit (the eighth) for Parity, which may represent either ODD or EVEN parity. Thus, the controller can accommodate your computer's choice of parity (odd or even) and perform parity checks on your computer's data transmission. The controller will return STATUS CODE 04 if it detects incorrect parity.
Baud Rate	This is the transmission speed in bits per second. In order to communicate properly, the controller must be set to the same Baud Rate as your computer. The Baud Rate selections are: 300, 600, 1200, 2400, 4800, 9600, or 19,200.
Communication Units	This selection determines how the controller values are expressed during communications: Percent of span or Engineering units.
Communications Setpoint Ratio	Ratio value for computer setpoint. The range is from -20.00 to +20.00.
Communications Setpoint Bias	Bias value for computer setpoint. The range is from -999 to 9999.

Continued on next page

Preparing the Controller for Communications, Continued

Procedure

The procedure in Table 3-2 tells you what keys to press on the controller keyboard, the upper and lower display indications, and the range of settings available to you. Not all prompts may be available for your particular controller.

Use ▲▼ to make adjustments to the range of setting or selection

Table 3-2 Controller Procedure for Communication Parameters

Step	Press	Lower Display	Upper Display Range of Setting or Selection	Parameter Description
1	SET UP	COMMUN		
2	FUNC	successive presses of the [FUNCTION] key will sequentially display all the functions and their values or selections.		
		COM STATE	DISABLE DMCS RS422	Communication State
		ADDRESS	01 to 99* * Address 00 disconnects it from the link	Communication Address (Loop 1)
		ADDRESS 2	01 to 99* (must be different from Loop 1) * Address 00 disconnects it from the link	Communication Address (Loop 2)
		SHED TIME	0 to 255 Sample periods 0 = No Shed will occur	Shed Time
		PARITY	ODD EVEN	Parity
		BAUD RATE	300 4800 600 9600 1200 19200 2400	Baud Rate (bits/second)
		SHED MODE	LAST FAILSAFE TO MAN TO AUTO	Controller Shed Mode and Output Level
		SHED SP	TO LSP TO CSP	Shed Setpoint Recall

Continued on next page

Preparing the Controller for Communications, Continued

Procedure, continued

Table 3-2 Controller Procedure for Communication Parameters

Step	Press	Lower Display	Upper Display Range of Setting or Selection	Parameter Description
		UNITS	PERCENT ENG UNITS	Communication Units
		CSP RATIO	-20.00 to +20.00	Commun. SP Ratio (Loop 1)
		CSP BIAS	-999 to +9999	Commun. SP Bias (Loop 1)
		CSP2 RATIO	-20.00 to +20.00	Commun. SP Ratio (Loop 2)
		CSP2 BIAS	-20.00 to +20.00	Commun. SP Bias (Loop 2)
3	LOWR DISP	TO RETURN TO NORMAL CONTROL		

Programming Your Computer

Introduction

To program your computer for communication with the various controllers on the link, you write input and output statements to send and receive ASCII character strings to and from the controller. (See ASCII and Hexadecimal conversion table in Section 9.) You treat the controller like any I/O device.

Request

To send a request, you program your computer to output the appropriate character string to the controller.

Response

To get a response, you program your computer to input the expected character string from the controller.

Example

The following programming statements show how you would output a request message and read the resulting response. This example is written in Fortran and uses the following assignments:

- I/O Channel 5 for your computer's RS422/485 Transmit Data Line.
- I/O Channel 6 for your computer's RS422/485 Receive Data Line.
- I/O Channel 7 for your computer's printer or terminal.

Table 3-3 lists the programming statements for this example.

Table 3-3 Programming Statements

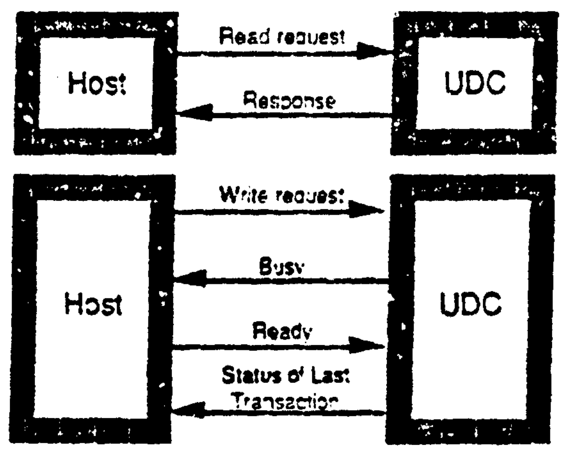
Step	Statement	Action
Sending the Request	10 Write (5,20) 20 Format ("XXXXXXX")	Writing the character string the character string XXXXXXX to I/O channel 5 which transmits the character string XXXXXXX to the controller.
Getting the Response	30 Read (6,40) Reply 40 Format (12)	Reading the character string at I/O Channel 6 which receives data from the controller into reply.
Displaying the Response	50 Write (7,60) Reply 60 Format (12)	Writing the contents of Reply to I/O Channel 7, a printer or terminal

Message Exchange

What is a message exchange?

Your computer communicates with the UDC controllers using the RS422/485 link. Each communication takes place as a message exchange: Your computer sends a request message (ASCII characters), and then waits for the resulting response from the controller involved (ASCII characters). Figure 3-1 shows how this occurs.

Figure 3-1 Message Exchanges



Sending requests

Your computer is the host, it initiates a message exchange. The UDC controllers are respond-only devices.

When you send a Read request, the UDC responds with the data requested. If you write configuration or override data into a UDC, the UDC responds with a Busy message (0082xx). The host should send a Ready message at which time the UDC will respond with a status of the write transaction. Communication with a single UDC should not be faster than 1/3 second.

Until the UDC completes processing of the data, any subsequent valid message received is answered with a busy response.

Request Messages

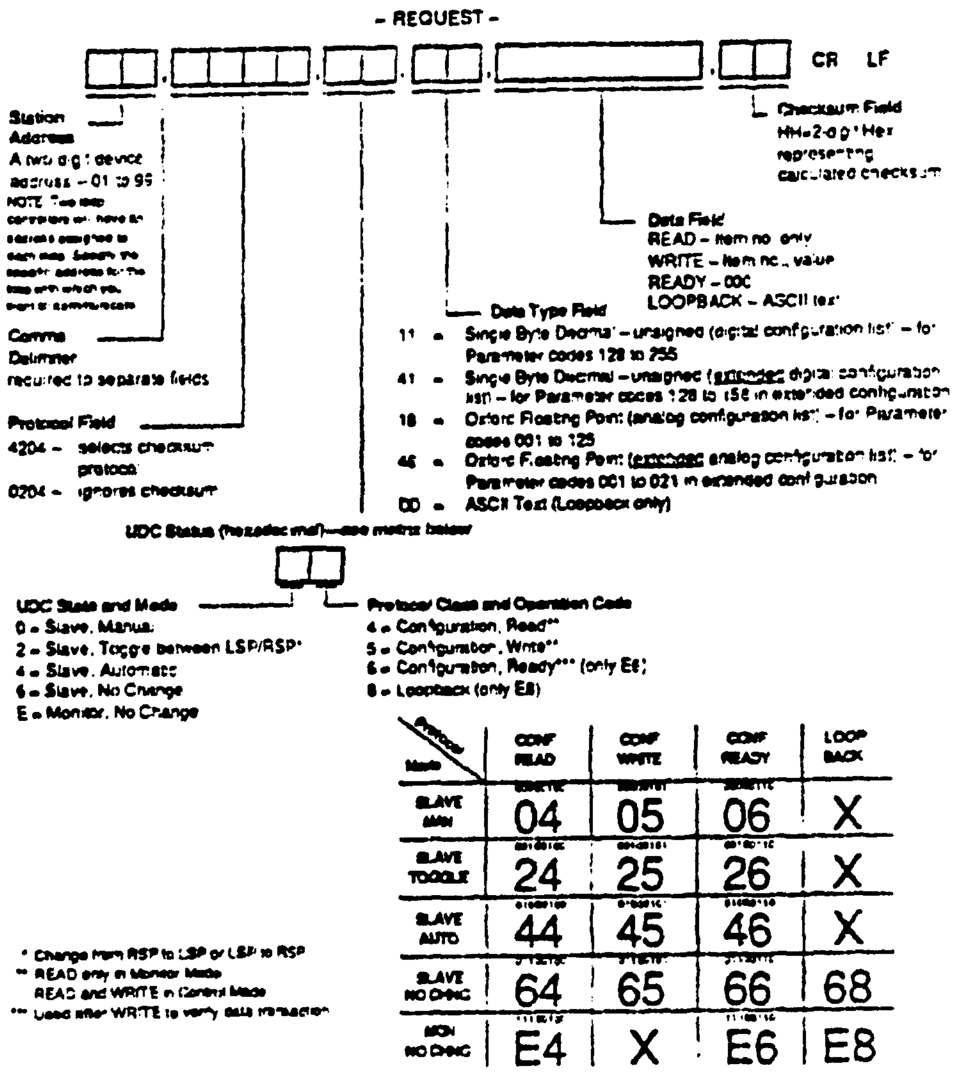
What is a request message?

Your computer queries a controller and indicates the communication function, or operation, that the controller should perform by sending a request message. Request messages are composed of standard fields, separated by commas. Each field contains a certain kind of information which you must enter in order to have a valid request message.

Request message fields

Figure 3-2 shows the request message fields and the selections that may be entered into each field. Table 3-4 lists these selections and their definitions.

Figure 3-2   Request Message Fields



Mode \ Protocol	CONF READ	CONF WRITE	CONF READY	LOOP BACK
SLAVE MAN	04	05	06	X
SLAVE TOGGLE	24	25	26	X
SLAVE AUTO	44	45	46	X
SLAVE NO CHNG	64	65	66	68
MON NO CHNG	E4	X	E6	E8

Request Messages

Request message field selections

Table 3-4 is a list of selections for the request message fields and their definitions.

Table 3-4 Request Message Fields Definitions

Selection	Definition
Station Address	A two digit device address – from 01 to 99 – that identifies the specific controller you are addressing. You must assign a unique station address to each controller on the link. For a 2 Loop controller, two distinct addresses must be configured. One address is used to designate Loop 1; and one is used to designate Loop 2. Either address may be used for transactions which are loop independent. See "Preparing the Controller for Communications" in this manual. A UDC will not respond to address 0 since the address results in a disconnect.
Protocol Field	A four digit number that selects whether or not you are going to use a Checksum Protocol (for increased data security) with your message exchange. • 4204 selects Checksum Protocol – see "Checksum Protocol" • 0204 ignores Checksum Protocol Any sequence utilizing other than 4 or 0 in the first digit results in an error with an error message returned.
UDC State and Mode	A hexadecimal number that determines what state you want the UDC to be in (monitor or slave) and the mode of operation desired (manual or automatic). You can also change the controller setpoint from Local setpoint to Remote setpoint or vice-versa. ATTENTION Any change made in UDC State or Control mode will not be indicated in the response until the next transaction.
Protocol Class and Operation Code	A hexadecimal number that allows you to do a Loopback or do a READ, WRITE, or READY transaction.

Continued on next page

Request message field selections, continued

Table 3-4 Request Message Fields Definitions, Continued

Selection	Definition
Data Type Field	A two digit number that specifies the format, or data type, of each of the parameters that can be accessed in the UDC controller. 11 = Single Byte Decimal (unsigned) – used with configuration protocol for digital parameter code numbers 128 through 255. 41 = Single Byte Decimal (unsigned) – used with configuration protocol of extended digital parameter code numbers (UDC 6000). 18 = Floating Point Format – used with configuration protocol for analog parameters code numbers 001 through 125. 48 = Floating Point Format – used with configuration protocol for extended analog parameter code numbers (UDC 6000) DD = ASCII Text – Used with loopback protocol only
Data Field	The data in this field is determined by the type of request: • READ – three digit parameter code which identifies a particular parameter for which you want to know the value or selection. • WRITE – three digit parameter code, which identifies a particular parameter you want to change, a comma (,), and the value or selection you want to enter. • READY – three zero's (000) – used in conjunction with a write request. Sent after a write request to verify that the information transmitted was received. • LOOPBACK – ASCII Text
Checksum Field (Optional)	This field is a one byte hexadecimal value (two ASCII characters) representing the binary sum, ignoring carries, generated by adding the ASCII code for each character in the message exchange, up to but not including the checksum and the CR and LF characters • No Characters = No Checksum • HH = two digit hexadecimal number representing the calculated checksum
Carriage Return/Line Feed	Terminates a message. The message will not be exchanged unless used in this order (CR LF).

Response Messages

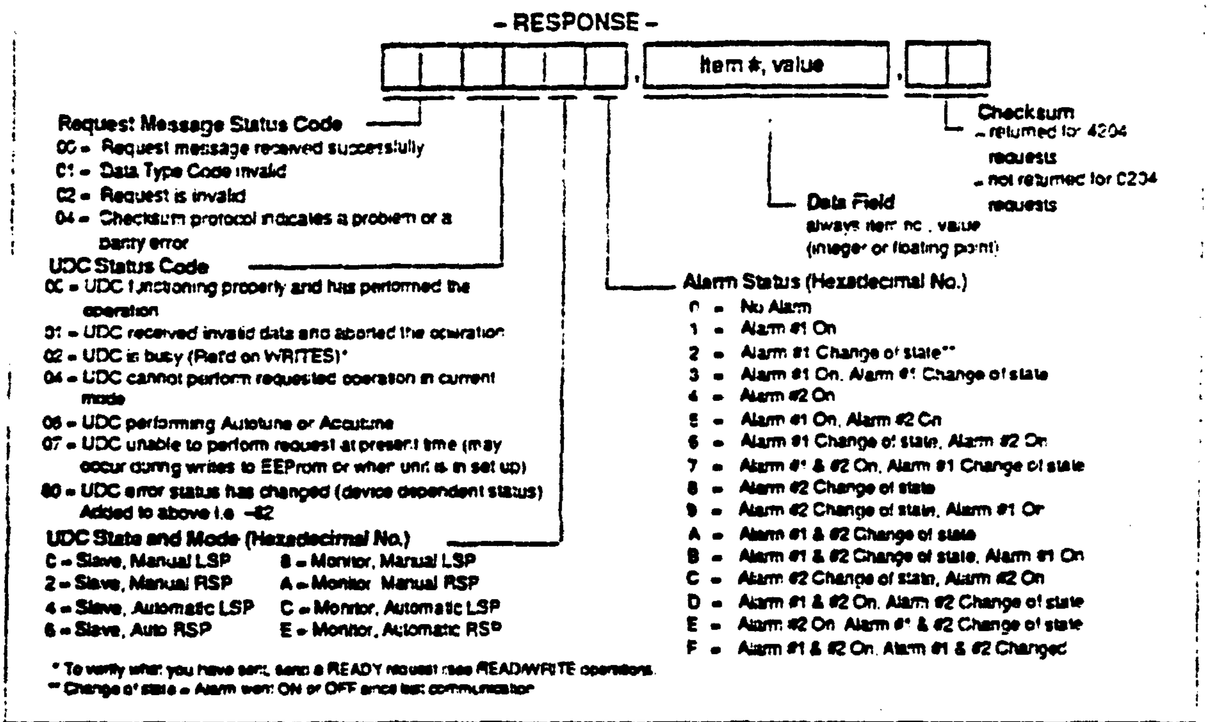
What is a response message?

The response message tells your computer the present status of the operation initiated by the request message. Response messages are composed of standard fields, separated by commas.

Response message fields

Each field contains a certain kind of information. Figure 3-3 indicates the response message fields and lists the information that could be returned in each field.

Figure 3-3 Response Message Fields Information



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Response Messages Continued

Response message field information

Table 3-5 is a list of the information contained in the response message and their definitions.

Table 3-5 Response Message Fields Definitions

Type of Information	Definition
Request Message Status Code	A two digit code that indicates whether or not the present request message was successfully processed. For detailed explanations and recovery procedures for these codes, refer to "Request Message Status Codes" in this section.
UDC Status Code	A two digit code that indicates whether or not the UDC controller addressed is working correctly and has performed the requested operation. For detailed explanations and recovery procedures for these codes refer to "UDC Status Codes" in this sections
UDC State and Mode	A hexadecimal number that indicates whether the UDC controller's present state is "Slave" or "Monitor" and whether it is in Manual or Automatic mode using the Local setpoint or Remote setpoint. **ATTENTION** Any change made in UDC State or Control mode will not be indicated in the response until the next transaction.
Alarm Status	A hexadecimal number that indicates the status of Alarm #1 and #2 or both. It indicates when the Alarm is on or has changed state since last communication. The change of state indicator is a backup to the on/off state indicator. If an alarm goes from off to on then off in between consecutive communications, the on/off would not show it. The change of state flag would show that it had happened.
Data Field	This field always returns the identifying number for the parameter in the request message and the value for that parameter (either an integer or field floating decimal point).
Optional Checksum Field	This field is a one byte hexadecimal value (two ASCII characters) representing the binary sum, ignoring carries generated by adding the ASCII code for each character of the response message, ignoring parity, up to but not including the checksum. It is returned for 4204 requests only. See "Checksum Protocol" in this section.

Status Codes

Request message status codes

The codes, listed in Table 3-6, indicate whether or not the request message was successfully processed. A suggested recovery procedure is listed for those that indicate an error.

Table 3-6 Request Message Status Codes

Request Message Status Code	Explanation	Suggested Recovery
00	The request message was successfully processed.	Not applicable.
01	Request message format invalid	Check format of request message. Resend message.
02	Request is invalid. The controller addressed does not support the requested operation.	Check parameter identifying code and value.
04	Checksum indicated in the request message differs from the checksum the UDC calculated. Or UDC has detected incorrect parity for character transmitted in request.	Check checksum calculations. Resend message.

Continued on next page

Status Codes, Continued

UDC status codes

All the controllers on the link return the UDC Status Codes listed in Table 3-7. A suggested recovery procedure is listed for those that indicate an error.

Table 3-7 UDC Status Codes

UDC Status Code	Explanation	Example	Suggested Recovery
00	UDC functioning properly and has received the message correctly.		Not applicable
01	UDC has received invalid data from the computer and did not perform the requested operation.	Data error. Configuration item number incorrect, data out-of-range or incorrect.	Check the UDC's configuration and limits.
02	UDC is busy until the data received is processed.	Returned after each write when a controller is processing a change to configuration database.	1. Do ready request to see if information received 2. Wait, then resend request.
04	UDC cannot perform the requested operation in its current mode.	1. Request error, request illegal, request incorrect in present state (Calib). 2. Requested illegal mode change. 3. Data received in wrong format.	Check configuration with last request. Check data field and data type field
06	The UDC is performing Autotune.	Returned when the controller is performing the Autotune function.	Wait or stop Autotune, then resend message.
07	UDC unable to perform request at present time.	May occur during writes to EEProm or when unit is in set up and data changing via the keyboard.	Wait, resend request
+80	UDC status change	Indicates one or more of the following have changed.*	Read 255 code

*Emergency manual, Failsafe, Working calibration checksum error, Configuration checksum error, Factory calibration error, Hardware failure, Restart after shed, Configuration/calibration memory changed.

Checksum Protocol (for Data Security)

Introduction

The optional Checksum Protocol is used to increase security on the RS422/485 link. This protocol enables both your computer and your UDC to detect messages that the RS422/485 link has transmitted inaccurately. Thus, this protocol makes the RS422/485 communications link more reliable.

CAUTION

Failure to use checksum protocol could make the undetected error rate for the RS422/485 link unacceptable for your process control application.

Using checksum protocol

You can use the checksum protocol with any message exchange. The UDC uses the protocol to check the transmission of request messages. Your computer uses the protocol to check the transmission of response messages.

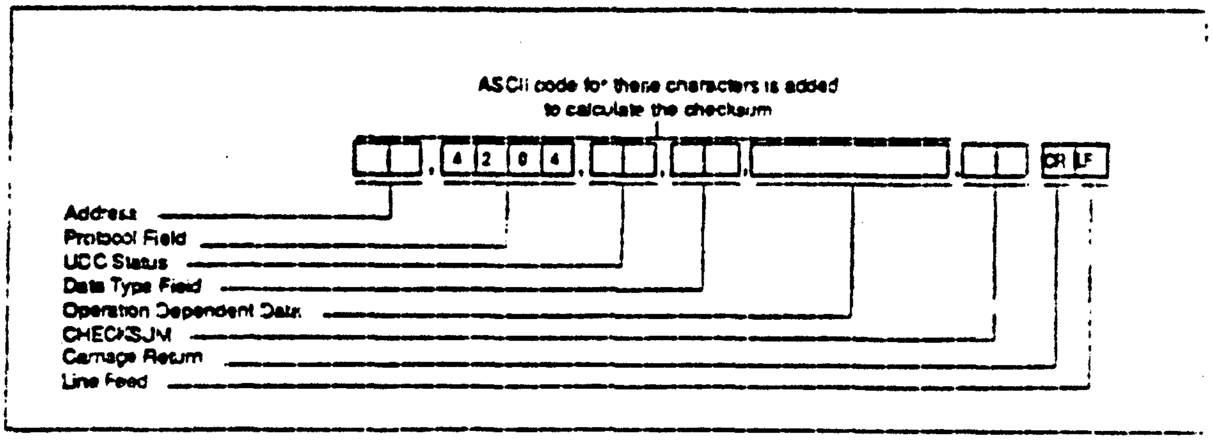
When a message exchange includes checksum protocol:

- Your UDC can tell, with high probability, if the ASCII code in the request message has changed during transmission from your computer.
- Your computer can tell, with high probability, if the ASCII code in the response message has changed during transmission from the UDC.

To use Checksum Protocol, you change the format of the request message as shown in Figure 3-4 as follows:

- You use a 4204 in the request format.
- You insert a 2-digit Hexadecimal number that represents the checksum that you have calculated from the ASCII codes in the request message as explained in "Calculating the Checksum". See Section 9 for an ASCII Conversion table and a Hexadecimal Binary table.

Figure 3-4 Request Format for Checksum Protocol



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Checksum Protocol (for Data Security), Continued

Calculating the Checksum

Table 3-8 lists the procedure for calculating the checksum. See Figure 3-5 for an example.

Table 3-8 Calculating the Checksum Procedure

Step	Action
1	Take the binary sum ignoring carries generated by the most significant bits, of the ASCII code for each of the message's characters, ignoring parity, up to but not including the CHECKSUM field and the CR and LF characters. The final sum should be an 8-bit binary number. See Section 9 for ASCII Conversion table and Hexadecimal to Binary table.
2	Convert the four least significant bits of this sum to the equivalent hexadecimal digit. This becomes the least significant digit in the CHECKSUM field.
3	Convert the four most significant bits of this sum to the equivalent hexadecimal digit. This becomes the most significant digit in the checksum field.

Continued on next page

Checksum Protocol (for Data Security), Continued

Checksum calculation example

Figure 3-5 shows an example of the result of a checksum calculation according to instructions in Table 3-8.

Figure 3-5 Example of Checksum Calculation

Example

03,4204,E4,18,001,7C CR LF

0	0011	0000
3	0011	0011
	0110	0011
,	0010	1100
	1000	1111
4	0011	0100
	1100	0011
2	0011	0010
	1111	0101
0	0011	0000
	0010	0101
4	0011	0100
	0101	1001
,	0010	1100
	1000	0101
E	0100	0101
	1100	1010
4	0011	0100
	1111	1110
,	0010	1100
	0010	1010
1	0011	0001
	0101	1011
8	0010	1000
	1001	0011
,	0010	1100
	1011	1111
0	0011	0000
	1110	1111
0	0011	0000
	0001	1111
1	0011	0001
	0101	0000
,	0010	1100
	0111	1100
Hex →	7	C (Checksum)

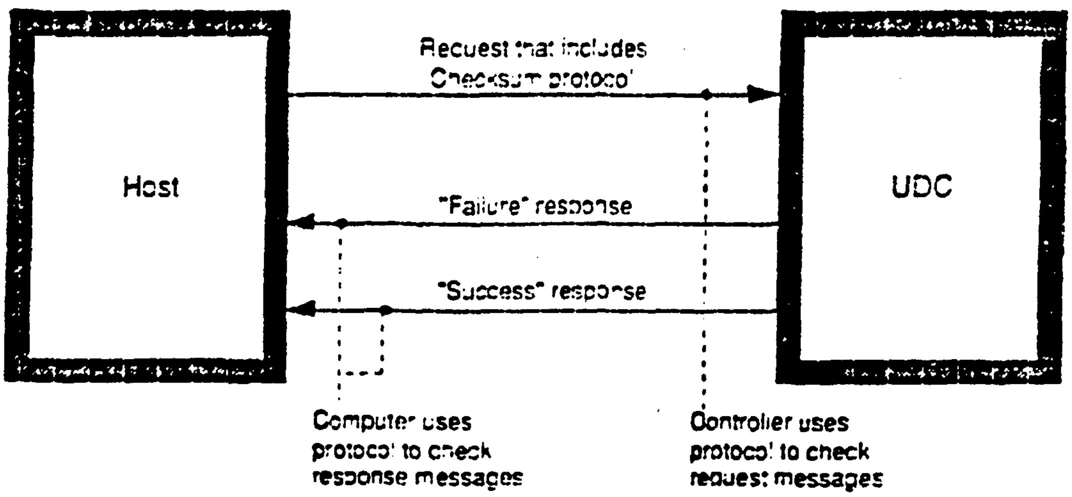
Continued on next page

Checksum Protocol (for Data Security), Continued

Success or failure

After receiving a request that uses checksum protocol, the UDC calculates the checksum of the characters received and compares this to the hexadecimal number stated in the checksum field. Depending on whether the checksums agree, the UDC returns either the "success" or "failure" response. Figure 3-6 indicates what happens when checksum protocol is used.

Figure 3-6 Using Checksum Protocol



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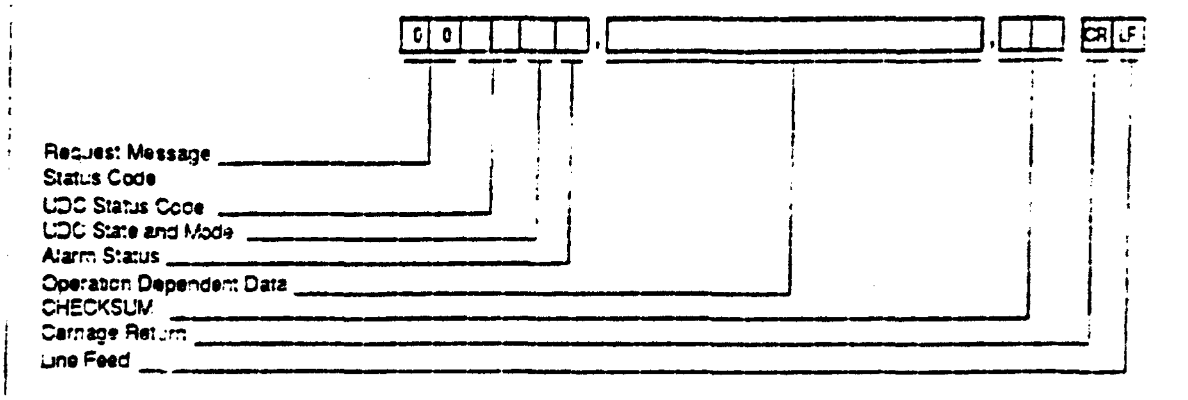
Checksum Protocol (for Data Security), *Continued*

Success response

If the checksums agree – and no other problems are encountered – the UDC returns the success response beginning with Request Message Status Code 00. Figure 3-7 indicates this response.

Figure 3-7 "Success Response" Message Fields



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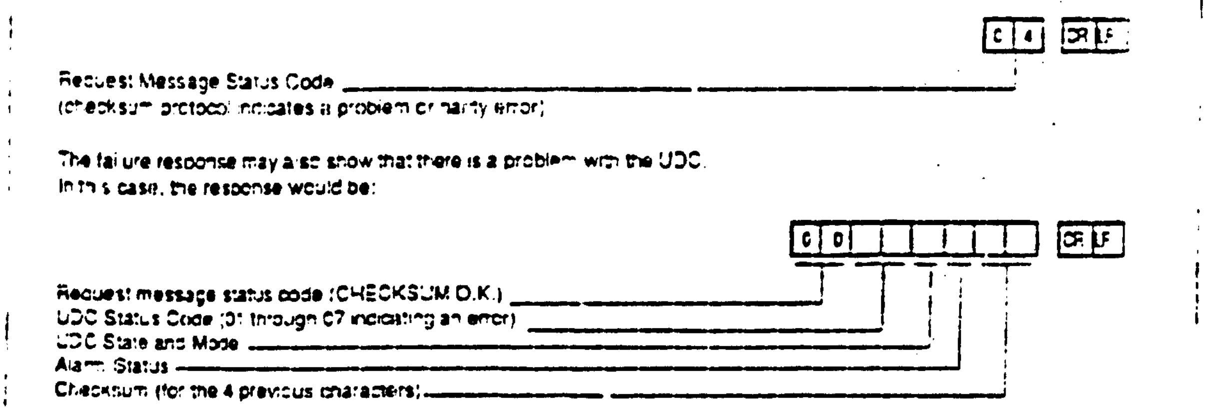
Failure response

If the checksums disagree, UDC ignores the request and returns the failure response Request Message Status Code 04. To recover, your computer repeats the operation. Figure 3-8 indicates this response.

Figure 3-8 "Failure Response" Message Fields



Checksum Calculation

After receiving a response that has checksum protocol, your computer should perform the checksum calculations on the characters received, and compare the results to the checksum in the response message. If the checksums disagree, your computer should repeat the operation.

ATTENTION

If there is a problem with the UDC itself, a UDC Status Code indicating an error will be returned.

Shed

What is Shed?

Shed happens when the controller, which has been working in "Slave," reverts to "Stand Alone" mode. Upon receiving a "Slave" message, the controller resets the "SHED TIMER." If this timer expires before the next valid message, the controller goes to stand alone operation. When the host reconnects with a valid message, the response will indicate as 8 at the third digit to indicate a restart after shed.

Thus SHED acts as a safeguard in case the computer or communications link fail. If something prevents the computer from communicating with the controller the device returns to the local control mode. The local operator is then able to regain control over the controller and operate it by the keyboard.

Shed time

Shed Time works like a timer. The number selected will represent how many sample periods there will be before the controller sheds from computer control. You can configure the shed time to be one that is between 1/3 second and approximately 83 seconds. 0 = No Shed.

Shed controller mode and output level

This determines the mode of local control whenever the controller is shed from the communication link.

Shed setpoint recall

This determines what setpoint will be used if the controller is shed from the communications link.

How to enter this information

Refer to "Preparing the Controller for Communications" in this section for these selections and procedure for entering the information into the controller.

Loopback

Making sure all the controllers are on-line

Once you have established communications between the UDC controller and your computer and understand the message exchange, it is a good idea to test communications to all the controllers on the RS422/485 link. The LOOPBACK operation is an easy way to do this. By including the appropriate address in the loopback operation, you can send a series of characters from your computer to any device on the link.

After receiving these characters, the device addressed "echoes" back the same characters. By comparing the characters sent to those returned, you can tell whether communications are working correctly.

Loopback message exchange

With this message exchange, you can test the communication link between your computer and any controller.

- In the request message, your computer sends a series of characters to the desired device.
- In the response message, the device returns the characters it received to your computer.

Request message

Table 3-9 is an example of the Loopback Request Message with or without the checksum.

Table 3-9 Example of Loopback Request Message

Protocol	Message Format
With Checksum	AA,4204,E6,DD,123456789ABC,CS CR LF (12 characters max.)
Without Checksum	AA,0204,E6,DD,123456789ABCDE, CR LF (14 characters max.) *Where:* AA = Status Address

Continued on next page

Response message

Table 3-10 is an example of the Loopback Response Message with or without the checksum.

Table 3-10 Example of Loopback Response Message

Protocol	Message Format
With Checksum	OOSSMA,123456789ABC,CS CR LF
Without Checksum	OOSSMA,123456789ABCDE, CR LF *Where:* OO = UDC Type Error SS = UDC Status M = Mode (Hex – see "Message Exchange") A = Alarm Data (Hex – see "Message Exchange")

Programming example

The programming statements in Table 3-11 show how you could perform the LOOPBACK operation with the UDC controller that has station address 09– not using checksum.

If the LOOPBACK operation is successful, these statements would print: OOOOMA,HELLO#09.

Where: M = Mode
A = Alarm Data

Table 3-11 Programming Example

	Programming Statement	Result
Request	10 Write (5,20) 20 Format ("09,0204,E8,DD,HELLO#09")	Sending the LOOPBACK request message that contains the eight characters HELLO#09 to the controller with station address 09.
Response	30 Read (6,40) Reply 40 Format (A15) 50 Write (7,60) Reply 60 Format (A15)	Receiving and printing the response message that contains the characters returned.

Recovering from Communications Failures

What is a lost message?

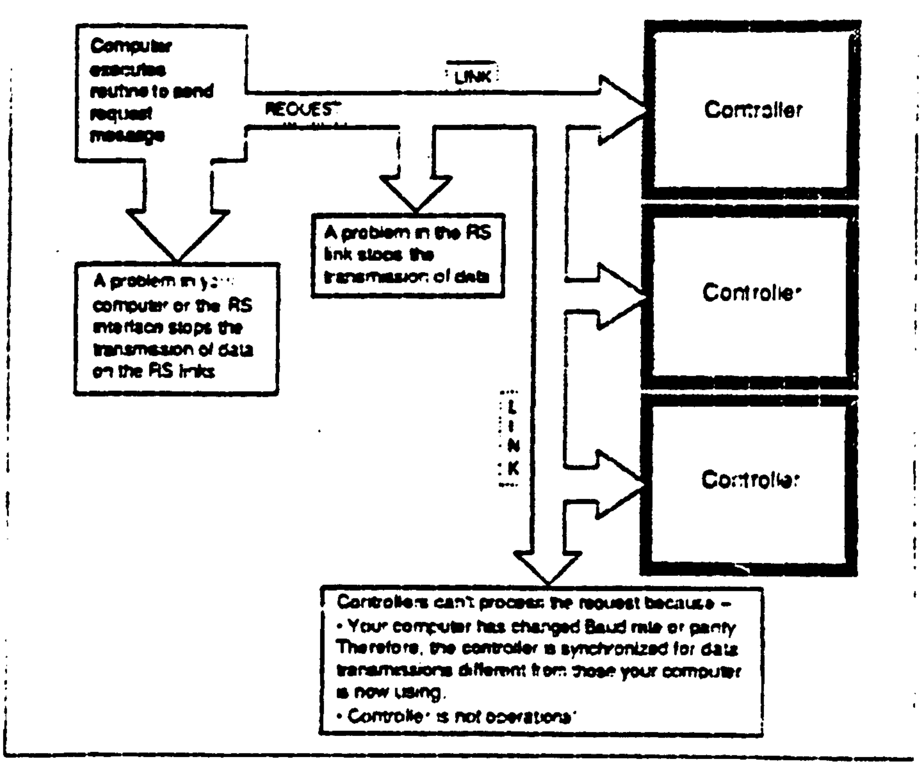
When your computer sends a request message but doesn't receive a response, a message (either the request or the response) has been lost on the link. As shown in Figure 3-9, problems in your computer, the link, or the controller could cause a message to get lost.

What happens to a lost message

Depending on how your programming handles messages, a lost message could hang up your programming forever. Suppose your programming uses a high-level language input command (in Fortran, READ) to retrieve response messages from the input device or buffer fed by the link. Upon executing this input command, your computer goes to the input device to retrieve the response message and waits there until the data arrives. If a message is lost, the message exchange is never completed. Thus, the input command is left waiting for a response message that will never arrive.

As you can see, you must design your programming to handle the possibility that the messages will get lost on the link. Make sure that your programming includes a timing routine that detects the lost message and aborts the pending input command.

Figure 3-9 Lost Messages



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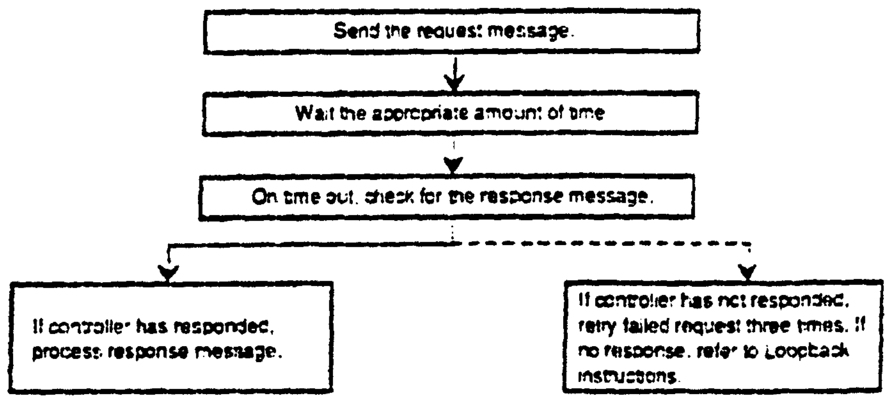
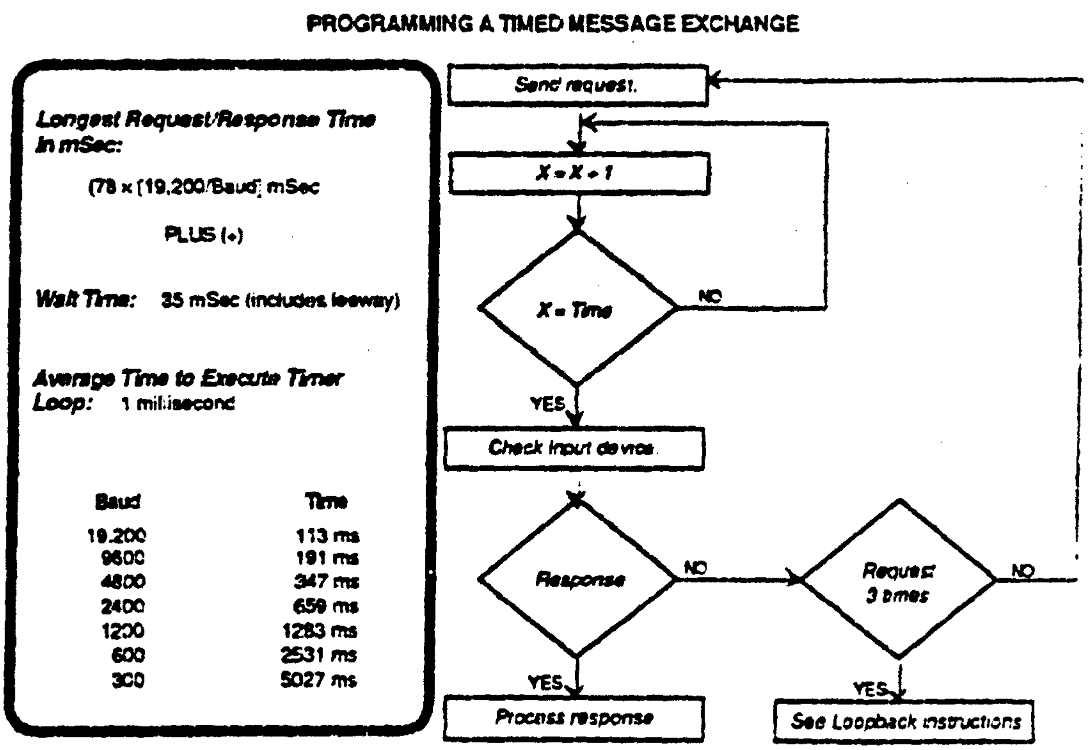
Recovering from Communications Failures, Continued

Timing message exchanges to detect lost messages

The flowchart in Figure 3-10 shows how to time a message exchange so that you can tell if a message has been lost. (This is only an example, not the suggested method.) Like all timing routines, this one includes a wait and a read interrupt (in Basic, a PEEK) rather than a standard input command.

Figure 3-10 Timing a Message Exchange and Checking for a Response





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Recovering from Communications Failures, Continued

Wait

The WAIT is the amount of time that your computer will wait for a response before assuming that a message has been lost. If the response doesn't appear in the allotted time, your computer should retry the request – up to three times. If your computer still hasn't gotten a response, your programming assumes that communications on the link have failed and calls the recovery or alarm routine.

Read Interrupt

The READ interrupt merely checks that input device or buffer for data, instead of waiting indefinitely until data arrives.

How long to wait

Before you can program a timing routine, you must determine how long to wait for a response. This wait must be at least as long as the response time for the longest message exchange when executed at your computer's baud rate. Also note that after the UDC has completed sending a response to your computer, it will require up to 1/3 second of additional processing time before it is ready to accept any new request message. If your computer sends a request to the UDC while it is still busy processing the previous request, it will respond with a BUSY status. Your computer can handle this situation by re-trying the request.

Timing routine

Once you have established the appropriate wait time, you can program the timing routine. To do so, you loop an instruction until the desired wait time has elapsed, as shown in the figure on the previous page.

This timing routine is the simplest one you could program. But it is not efficient – your program waits the same amount of time for the shortest message as the longest. You devise a more efficient routine, such as a loop that checks for the response message each time "X" increments.

Section 4 – Read and Write Operations

Read Operations

Introduction

The Read operations (Data Retrieval) allow your computer to read data from any controller on the RS422/485 link. Data retrieval for each operation is accomplished through a message exchange between your computer and the device you are addressing.

You can request the data for only one identifying code at a time, but, the response may be a single variable or a three variable type depending on the code used.

Transaction states

Read transactions can be performed in either UDC state: Monitor or Slave.

ATTENTION Any change made in UDC state or control mode will not be indicated in the response until the next transaction.

Analog or digital

The parameters being read will be either Analog (codes 1 through 125) or Digital (Codes 128 through 255) value or selections so that all Read message formats must adhere to the standardization rules shown in the tables that follow.

Read Analog Parameters

Introduction

The Analog identifying Codes are codes 001 through 125. Each of these codes are read using the Request and Response formats shown in tables 4-1 and 4-2.

Request format

Table 4-1 lists the request format with or without checksum for Analog I.D. Codes 001 through 125.

Where:

AA	=	Station Address (Each loop of a 2 loop controller has a unique address – see "Message Exchange")
X	=	UDC State and Mode (Hex – see "Message Exchange")
NNN	=	Identifying Code for Analog Parameter (001 to 125)
CS	=	Checksum Value (2 digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-1 Analog Parameter Request Format

Format Type	Format
With Checksum	AA. 4204, X4, 18*, NNN, 0, CS CR LF
Without Checksum	AA 0204, X4, 18*, NNN, 0, CR LF

*Use 48 for extended analog configuration I.D. codes (001 to 021), UDC 6000 only.

Continued on next page

Read Analog Parameters, Continued

Response format

Table 4-2 lists the response format, single or three variable with or without checksum, for Analog I.D. Codes 1 through 125.

Where:

OO	=	UDC Type Error (00 = No Error)
SS	=	UDC Status
M	=	Mode (Hex – see "Message Exchange")
A	=	Alarm Data (Hex – see "Message Exchange")
NNN	=	Identifying Code for Analog Parameter
DDD.D	=	Floating Point Value
CS	=	Checksum (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-2 Analog Parameter Response Format

Variable	Format Type	Format
Single	with checksum	OOSSMA, NNN, DDD.D, CS, CR LF (see note 1)
	without checksum	OOSSMA, NNN, DDD.D, CR LF (see note 1)
Three	with checksum	OOSSMA, NNN, DDD.D, DDDD, DDD.D, CS, CR LF (see note 1)
	without checksum	OOSSMA, NNN, DDD.D, DDD.D, DDDD., CR LF (see note 1)

Note 1. Floating point values may look like this:

DDDD.	DDD.D	DD.DD	D.DDD
-DDD.D	-DDD.	-DD.DD	-D.DDD

They must have four characters and one decimal point as shown, negative sign as an extra character.

Continued on next page

Read Analog Parameters, *Continued*

Example

Figure 4-1 is an example of a Read Analog Parameter message exchange: specifically, Read the value of heat gain: Analog I.D Code 001.

Figure 4-1 Read Analog Parameter Message Exchange

request 03 , 0204 , E4 , 1B , 001 , 0 CR LF

- Address — 03
- Protocol Field (without checksum) — 0204
- UDC State and Mode — E4
  - E = monitor, no change
  - 4 = configuration, read
- Data Type Code for Analog — 1B
- Identifying Code for Heat Gain — 001
- Place Holder for Data Values — 0

response 00 00 C0 , 001 , 035.0 CR LF

- No UDC Error — 00
- No Change in Status — 00
- Monitor — C0
- No Alarm — C0
- Heat Gain Identifying Code — 001
- Value of Heat Gain — 035.0

Read Digital Parameters

Introduction

The Digital identifying codes are Codes 128 through 255. Each of these codes are read using the Request and Response formats shown in Tables 4-3 and 4-4.

Request format

Table 4-3 lists the request format, with or without checksum, for digital I.D. Codes 128 through 255.

Where:

AA	=	Station Address (Each loop of a 2 loop controller has a unique address – see "Message Exchange")
X	=	UDC State and Mode (Hex – see "Message Exchange")
MMM	=	Identifying Code for Digital Parameter (128 to 255)
CS	=	Checksum Value (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-3 Digital Parameter Request Format

Format Type	Format
With Checksum	AA, 4204, X4, 11*, MMM, 0, CS, CR LF
Without Checksum	AA, 0204, X4, 11*, MMM, 0, CR LF

*Use 41 for extended digital configuration I.D. codes (128 to 158), UDC 6000 only.

Continued on next page

Read Digital Parameters, Continued

Response format

Table 4-4 lists the response format, with or without checksum, for digital I.D. codes 128 through 255.

Where:

OO	=	UDC Type Error (00 = No Error)
SS	=	UDC Status
M	=	Mode (Hex – see "Message Exchange")
A	=	Alarm Data (Hex – see "Message Exchange")
MMM	=	Identifying Code for Digital Parameter
DDD	=	Digital Value (always 3 characters)
CS	=	Checksum (2 digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

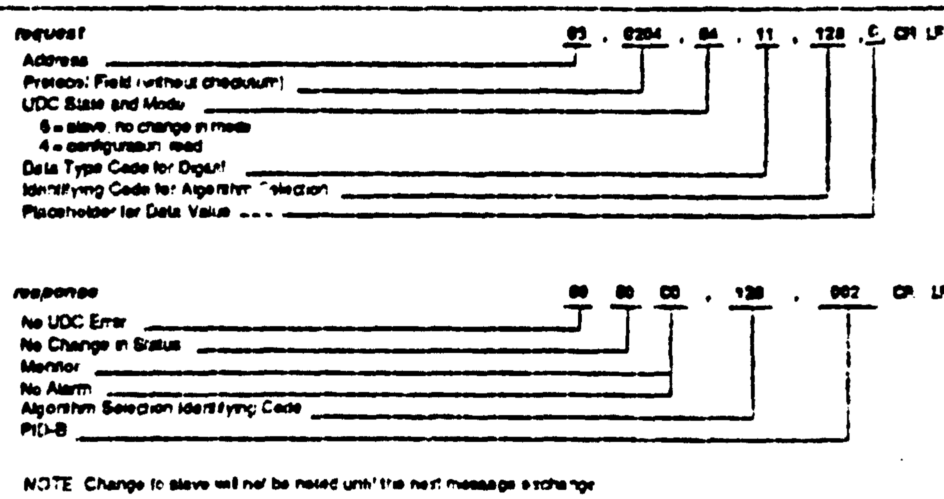
Table 4-4 Digital Parameter Response Format

Format Type	Format
With Checksum	OOSSMA, MMM, DDD, CS CR LF
Without Checksum	OOSSMA, MMM, DDD, CR LF

Example

Figure 4-2 is an example of a Read Digital Parameter message exchange; specifically, read the algorithm selection: digital I.D. Code 128 and maintain or change the UDC state to slave.

Figure 4-2 Read Digital Parameter Message Exchange



Write Operations

Introduction

The Write operations allow your computer to write data type transactions such as Overriding the PV, Setpoint, inputs as well as writing configuration data such as Tuning Parameters, Algorithm Selection, Setpoint Ramp Information, etc. to the controller.

Transaction state

Write transactions can only be performed in the Slave Mode.

Write message exchange

In a Write transaction, only single items are permitted to be written.

A Ready transaction is required to determine if the information was received.

Following any Write, a Busy indication is returned.

Table 4-5 lists the steps for the Write message exchange.

Table 4-5 Write Message Exchange Steps

Step	Action
1	Do a Write request to change a parameter (see Table 4- 6).
2	Receive a Busy response (see Table 4-7).
3	Send Ready request to see if the information has been processed (see Table 4-8).
4	Receive an "Is Ready" response (see Table 4-9).
5	Do a Read request to check the value (OPTIONAL).

CAUTION

The data stored in non-volatile memory is expected to be retained for 10 years. However, additional writes will degrade the retentivity of the non-volatile memory.

ATTENTION

Any change made in UDC State or Control Mode will not be indicated in the response until the next transaction.

Write Analog Parameters

Introduction

The analog identifying codes are codes 001 through 12· The Write request and response formats are shown in Tables 4-6, 4-7, 4-8, and 4-9.

Request format

Table 4-6 lists the write request format with or without checksum for Analog I.D. Codes 1 through 125.

Where:

AA	=	Station Address (Each loop of a 2 loop controller has a unique address – see "Message Exchange")
X	=	UDC State and Mode (Hex – see "Message Exchange")
NNN	=	Identifying Code for Analog Parameter (001 to 125)
DDD.D	=	Floating Point Value (see note 1)
CS	=	Checksum Value (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-6 Write Request Format for Analog I.D. Codes

Format Type	Format
With Checksum	AA, 4204, X5, 18*, NNN, DDD.D, CS CR LF (see note 1)
Without Checksum	AA 0204, X5, 18*, NNN, DDD.D, CR LF (see note 1)

*Use 48 for extended analog I.D. codes 001 through 021, UDC 6000 only.

Note 1 Floating point values may look like this:

DDDD.	DDD.D	DD.DD	D.DDD
-DDD.D	-DDD.	-DD.DD	-D.DDD

They must have four characters and one decimal point as shown, negative sign as an extra characters.

Continued on next page

Write Analog Parameters, Continued

"Busy" response

If the controller did not process the information, the controller will return a four digit status code indicating an error in the third and fourth digit. See "Status Codes."

Table 4-7 lists the busy response that can be received, with or without checksum, after a Write request that indicates a good write:

Where:

M	=	Mode (Hex - see "Message Exchange")
A	=	Alarm Data (Hex – see "Message Exchange")
CS	=	Checksum (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-7 "Busy" Response

Format Type	Format
With Checksum	0002MA, CS, CR LF
Without Checksum	0002MA, CR LF

"Ready" request

After receiving a "Busy" response, enter a "Ready" request. Table 4-8 lists the "Ready" request format, with or without checksum.

Table 4-8 Ready Requests

Format Type	Format
With Checksum	03, 4204, 66, 11, 0, CS CR LF
Without Checksum	03, 0204, 66, 11, 0, CR LF

Continued on next page

Write Analog Parameters, Continued

"Is Ready" response

This is the response to a Ready request. Table 4-9 lists the "Is Ready" response formats, with or without checksum.

Where:

SS	=	UDC Status
M	=	Mode (Hex - see "Message Exchange")
A	=	Alarm Data (Hex – see "Message Exchange")
CS	=	Checksum (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-9 "Is Ready" Response

Format Type	Format
With Checksum	00SSMA, CS, CR LF
Without Checksum	00SSMA, CR LF

Check write transaction

To check the value a change do a "Read" for the particular parameter (I.D. Code) you have changed.

Continued on next page

Write Analog Parameters, Continued

Example

Figure 4-3 is an example of a Write of an analog parameters message exchange: specifically to change the gain value from 5 to 10: analog I.D. Code 001.

Figure 4-3 Write Analog Parameter Message Exchange Example

request 03 . 0204 . 65 . 18 . 001 . 010.0 . CR LF

- Address — 03
- Protocol Format (without checksum) — 0204
- UDC State and Mode — 65
  - 6 = slave, no change
  - 5 = configuration, write
- Data Type Code for Analog — 18
- Identifying Code for Gain — 001
- Gain Value of 10 — 010.0

busy response 00 82 00

ready request 03,0204,66,11, 0 CR LF

is ready response 00 80 4 0 CR LF

- Request message received successfully — 00
- UDC functioning properly and performed operator — 80
- Control state, Automatic LSP Mode — 4
- No Alarm — 0

(OPTIONAL) Do a READ operation for Code 001 to verify change to 10.

Write Digital Parameters

Introduction

The digital identifying codes are Codes 128 through 225. The Write request and response formats are shown in Tables 4-10, 4-11, 4-12, and 4-13.

Request format

Table 4-10 lists the Write request format, with or without checksum, for digital I.D. Codes 128 through 255.

Where:

AA	=	Station Address (Each loop of a 2 loop controller has a unique address – see "Message Exchange")
X	=	UDC State and Mode (Hex – see "Message Exchange")
MMM	=	Identifying Code for Digital Parameter (128 to 255)
DDD	=	Digital Value (always three characters)
CS	=	Checksum Value (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-10 Write Request Format for Digital I.D. Codes

Format Type	Format
With Checksum	AA, 4204, X5, 11*, MMM, DDD, CS CR LF
Without Checksum	AA, 0204, X5, 11*, MMM, DDD, CR LF

*Use 41 for extended digital I.D. codes 128 through 158, UDC 6000 only.

"Busy" response

If the controller did not process the information, the controller will return a four digit status code, indicating an error in the third and fourth digit. See "Status Codes."

Table 4-11 lists the busy responses that can be received with or without checksum, after a write request that indicates a good write:

Where:

M	=	Mode (Hex - see "Message Exchange")
A	=	Alarm Data (Hex – see "Message Exchange")
CS	=	Checksum Value (2 digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Continued on next page

Write Digital Parameters, Continued

"Busy" response, continued

Table 4-11 Busy Response

Format Type	Format
With Checksum	OOO2MA, CS, CR LF
Without Checksum	OOO2MA, CR LF

"Ready" request

After receiving a "Busy" response, enter a "Ready" request. Table 4-12 lists the "Ready" request format, with or without checksum.

Table 4-12 Ready Request

Format Type	Format
With Checksum	03, 4204, 66, 11, 0 CS CR LF
Without Checksum	03, 0204, 66, 11, 0 CR LF

"Is Ready" response

This is the response to the Ready request. Table 4-13 lists the "Is Ready" response formats, with or without checksum.

Where:

SS	=	UDC Status
M	=	Mode (Hex - see "Message Exchange")
A	=	Alarm Data (Hex – see "Message Exchange")
CS	=	Checksum Value (two digit hex – see "Checksum")
CR	=	Carriage Return
LF	=	Line Feed

Table 4-13 "Is Ready" Response

Format Type	Format
With Checksum	00SSMA, CS, CR LF
Without Checksum	00SSMA, CR LF

Check write transaction

To check the value of a change, do a "Read" for the particular (I.D. Code) you have changed.

Continued on next page

Write Digital Parameters, Continued

Example

Figure 4-4 is an example of a Write of a digital parameter message exchange: specifically, to change the setpoint ramp time to 60 minutes (Code 174).

Figure 4-4 Write Digital Parameter Message Exchange Example

request 03 , 0204 , 65 , 11 , 174 , 060 , CR LF

- Address
- Protocol Format (without checksum)
- UDC State and Mode
  - 6 = slave, no change
  - 5 = configuration, write
- Data Type Code for Digital
- Identifying Code for SP Ramp Time
- SP Ramp Time in Minutes

busy response 00 82 00

ready request 03,0204,66,11,000,0 CR LF

is ready response 00 00 4 0 CR LF

- Request message received successfully
- UDC functioning properly and performed operation
- Control state, Automatic LSP Mode
- No Alarm

(OPTIONAL) Do a READ operation for Code 174 to verify change.

Section 5 – Read, Write and Override Parameters on UDC 3000 Versa-PRO Controllers

Overview

Introduction

This section contains information concerning reading, writing, and overriding parameters on the UDC 3000 Controllers. There are two types of parameters:

- Data Transfer—these parameters include reading control data, option status, and reading or changing setpoints or outputs.
- Configuration Data—all the configuration data is listed in the order in which it appears in the controller.

Each type of parameter has the identifying codes listed with it. Follow the message exchange rules listed in "Read and Write Operations."

What's in this section

This section contains the following topics:

Continued on next page

What's in this section, continued

General Information

Analog Parameters

- Whenever analog parameters 001 through 107 (those that can be changed via Communications) are changed, a write cycle occurs immediately after receipt of the message.

Override Parameters

- Override analog parameters 123, 124, and 125 (computer setpoint, output, and input) are not stored in non-volatile memory and can be changed as frequently as desired with no effect on non-volatile memory retentivity, but the controller must remain in slave mode.

Digital Parameters

- Whenever digital configuration parameters 128 through 250 are updated via communications, the non-volatile memory is updated as soon as the message is received.

Reading Control Data - UDC3000

Overview

You can Read the following control data from the UDC 3000 controller.

- Input 1
- Input 2
- PV
- Internal RV
- PV, Setpoint, Output

I.D. codes

Use the identifying codes listed in Table 5-1 to read the specific items. A Write request for these codes will result in an Error message.

Table 5-1 Control Data Parameters

Parameter Description	Identifying Code	Format Code	Range or Selection
Input #1	118	18	In Engineering Units or Percentage
Input #2	119	18	In Engineering Units or Percentage
PV	120	18	In Engineering Units or Percentage
Internal RV	121	18	In Engineering Units or Percentage
PV, Setpoint, and Output*	122	18	In Engineering Units or Percentage

*This READ request will give a three variable response (see READ/WRITE operation).

Read Option Status - UDC3000

Read

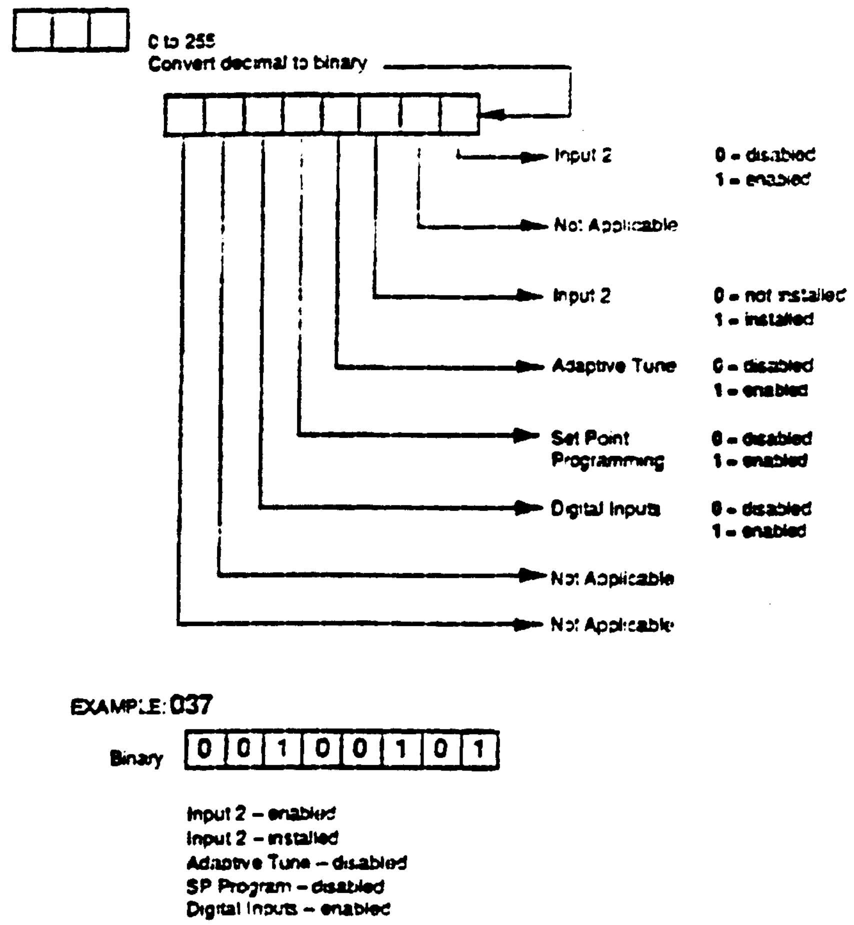
Doing a Read of I.D. Code 185 listed in Table 5-2 will tell you which of the available options are enabled/installed or disabled/not installed.

Table 5-2 Option Status

Parameter Description	Identifying Code	Format Code	Range or Selection
Option Status (read only)	185	11	See Figure 5-1

The data field in the response message will be a decimal number from 0 to 255. Convert the decimal number to binary as shown in Figure 5-1 to determine which options are or are not active.

Figure 5-1 Option Status Information



Miscellaneous Read Only's - UDC3000

I.D. codes for read only's

The identifying codes listed in Table 5-3 represent some parameters that are Read only. No Writes allowed.

Table 5-3 Miscellaneous Read Only's

Parameter Description	Identifying Code	Format Code	Range or Selection
Output Current Calibration 0%	33	18	READ only
Output Current Calibration 100%	34	18	READ only
Software Type	157	11	READ only 1 = Basic UDC 3000 2 = Field upgrade for Adaptive Tune 3 = Field upgrade for Adaptive Tune + Setpoint Programming 4 = Limit Controller
Software Version	167	11	0 to 225
UDC Error Status	255	11	See below READ/WRITE* 001 = Emergency Manual 002 = Failsafe 004 = Working Calibration Checksum Error 008 = Configuration Checksum Error 016 = Parameter Limit Indicator 032 = Hardware Failure 064 = Restart after Shed 128 = Configuration/Calibration Memory Changed

*Write to clear.

FOR EXAMPLE: If Read returns 192 (restart after shed-064 plus configuration change -128)

Write 192 to 255
Read returns 000 (clear)

Continued on next page

Error status definitions

Table 5-4 lists the UDC error status codes and their definitions.

Table 5-4 Error Status Definitions

Status Code	Error	Definitions
001	Emergency Manual	Indicates that the output of the unit which has been in slave operation is under manual control, locally. Error remains until local control is relinquished at the controller.
002	Failsafe	Error occurs whenever the control reverts to failsafe operation and remains as long as the condition exists.
004	Working Calibration Checksum Error	Indicates that an error exists in the working calibration data. Re-select the inputs to load factory calibration data or field calibrate the inputs.
008	Configuration Checksum Error	Error exists in the configuration data. Verify configuration data at the keyboard. Checksum will be recomputed by stepping the controller through the status tests.
016	Parameter Limit Indicator	A limit condition exists on one of the following: PV, RV, Input 1, Input 2, Input 3, Computer Setpoint. User must determine EXACT limit condition and correct.
032	Hardware Failure	Indicates either a RAM test failure or Input 1, Input 2, Input 3 failure on two consecutive conversions.
064	Restart After Shed	Error occurs whenever a shed of slave override is performed. Error is reset following a WRITE command to I.D. Code 255 (064).
128	Configuration /Calibration Memory Changed	Error occurs whenever shed, configuration, or calibration changed. Also occurs whenever there is a change of state in 001, 002, 004, 008, or 016. Error is reset following a WRITE command to I.D. Code 255.

Setpoints - UDC3000

Overview

You can use two separate setpoints in the UDC 3000 Controller. The identifying codes listed in Table 5-5 allow you to select which setpoint you want to use and to enter a value in Engineering Units or Percent (whichever is selected at Code 161) for that setpoint via communications.

I.D. codes

Make your selection using I.D. Code 173 and enter the value for the setpoint chosen using I.D. Code 39 (SP 1) or 53 (SP 2).

Table 5-5 Setpoint Code Selections

Parameter Description	Identifying Code	Format Code	Range or Selection
Local Setpoint #1	39	18	Value within the setpoint range limits
Local Setpoint #2	53	18	Value within the setpoint range limits
Local Setpoint Select	173	11	000 = Local Set Point #1 only 001 = 2nd Local Setpoint via keyboard or communications*

*I.D. Code 131—second input function must be set to 0 (LSP).

Associated parameters

Refer to Table 5-6 for the codes required to display or change any of the parameters associated with setpoints.

Table 5-6 Setpoint Associated Parameters

Parameter	Code
Setpoint Limits	007, 008
Computer Setpoint	125
Setpoint Program/Ramp	178

Using a Computer Setpoint (Overriding Controller Setpoint) - UDC3000

Overview

You can use a setpoint generated from the computer to override the setpoint being used by the controller.

The value generated by the computer will have ratio and bias applied by the controller.

I.D. Codes

Use the identifying code in Table 5-7 to enter the computer setpoint.

Shed

The computer setpoint override will continue until "SHED" from communications occurs or the controller is placed into monitor mode through communications. Doing periodic "SLAVE READS" within the shed time will allow the override to continue until communication is stopped and shed time elapses.

ATTENTION 0 Shed (code 154) allows the Override to continue indefinitely or until the Override is cancelled. (See Override selection I.D. Code 183)

Override display

When SP is overridden, the left most digit in the upper display becomes a "C."

Table 5-7 Computer Setpoint Selection

Parameter Description	Identifying Code	Format Code	Range or Selection
Computer Setpoint	125	18	Within the Setpoint Range Limits in Engineering Units or Percent.

Associated Parameters

Refer to Table 5-8 for the codes required to display or change any of the parameters associated with the computer setpoint.

Table 5-8 Computer Setpoint Associated Parameters

Parameter	Code
Setpoint Limits	007, 008
Local Setpoint #1	039
Local Setpoint #2	053
Local Setpoint Selection	173

Overriding Input 1 - UDC3000

Overview

You can override the Input 1 value in the controller using I.D. Code 124 as shown in Table 5-9.

Override display

When you override the PV, the first digit in the upper display becomes a "C."

Table 5-9 Input 1 Override Code

Parameter Description	Identifying Code	Format Code	Range or Selection
Override Input 1	124	18	Within the input 1 limits in Engineering Units or Percent (whichever is selected at I.D. Code 161).

Shed

The Override to Input 1 will continue until "SHED" from communications occurs or the controller is placed into monitor via communications. Doing Reads within the shed time will allow the override to continue until Reads are stopped and shed time elapses (I.D. Code 154).

ATTENTION 0 Shed allows override to continue indefinitely or until override is cancelled. (See Override Selection, I.D. Code 183.)

Associated Parameters

Refer to Table 5-10 for the codes required to display or change any of the parameters associated with Input 1.

Table 5-10 Input Override Associated Parameters

Parameter	Code
High/Low Range Values (Read Only)	029,030
Temperature Units (Read Only)	129
Input 1 Type (Read Only)	168
Transmitter Characterization (Read Only)	169
Input 1 Bias	107
Input 1 Filter Time Contrast	042
Burnout	164
Emissivity	023

Cancelling the Override - UDC3000

Overview

Doing a Read of I.D. Code 183 will tell you which Override is active—Input 1 (PV) or Setpoint.

Doing a Write lets you cancel either the Input 1 override set at Code 124 or setpoint override set at Code 125 or both.

I.D. codes

Using the identifying code in Table 5-11 to Read or Write your selection.

Table 5-11 PV or Setpoint Override Cancellation

Parameter Description	Identifying Code	Format Code	Range or Selection
Override Selection	183	11	001 = Cancels Input 1 (PV) Override 008 = Cancels Setpoint Override 009 = Cancels Both Overrides

The example below cancels both Input 1 and setpoint overrides:

XX,0204,65,11,183,009,0 CR LF

Reading or Changing the Output - UDC3000

Overview

You can read the output of a particular UDC 3000 controller (Read Transaction) or you can change it to suit your needs (Do a Write Transaction.)

I.D. Codes

Use the identifying code in Table 5-12 to monitor (Read) or change (Write) the output (in manual only).

ATTENTION To Write (change) the output, the controller must first be in manual mode.

Table 5-12 Reading or Changing the Output

Parameter Description	Identifying Code	Format Code	Range or Selection
Output	123	18	-5 to +105% of full span (current output) 0 to 100% (relay type output)

Associated Parameters

Refer to Table 5-13 for the codes required to display or change any of the parameters associated with the output.

Table 5-13 Associated Output Codes

Parameter	Code
Output Direction	135
Output Limits	14, 15
Output Dropoff Limits	20
Failsafe Output Values	40
Output Hysteresis	19
Output Type (Read only)	160

Local Setpoint/PID Set Selection /Setpoint Ramp Status - UDC3000

Overview

Identifying Code 250 lets you monitor or make selections for:

- Tuning Parameter Set #1 or #2
  If Tuning Sets selection is "two keyboard" code 171 = 001
- Local Setpoint #1 or #2
  If "2 Local Setpoints" is selected 131 = 0, 173 = 1
- Run or Hold Setpoint Ramp or a Set Point Program Data
  If SP Ramp or SP Program is enabled 178 = 1 Program, 178 = 2 Ramp

Read

Table 5-14 is a table of numbers that could be returned by the UDC 3000 controller. When a Read is requested for this I.D. Code (250) you can determine which parameters are active from this table.

Write

To Write information to the controller, select what parameters you want from Table 5-14 and enter the associated number in the data field of the Write request.

For example:

- Maintain TUNING SET #2
- Maintain LOCAL SET POINT #1
- CHANGE A SET POINT PROGRAM TO RUN

READ 250 response is 020 or 022
WRITE 250 (023), Response Busy
READ 250 Response is 023

Note: some of the numbers are Read only.

Table 5-14 LSP/PID Set Selection and Setpoint Ramp Status

Parameter Description	Identifying Code	Format Code	Range or Selection
Enhanced Function	250	11	See Figure 5-2

Continued on next page

Write, continued

Figure 5-2 I.D. Code 250 Indications

Tuning Set #2 Selection
Local Set Point #2 Selection

Tuning Set #2 Selection
Local Set Point #1 Selection

Tuning Set #1 Selection
Local Set Point #2 Selection

Tuning Set #1 Selection
Local Set Point #1 Selection

Set Point Ramp or Program Data Selections				
None or SP Ramp, Enabled Not in Progress (READ)	000	008	016	024
SP Ramp in Progress, Hold (READ/WRITE)	002	010	018	026
SP Ramp in Progress, Run (READ/WRITE)	003	011	019	027
SP Program, Enabled Not in Progress, (READ)	004	012	020	028
SP Program in Progress, Hold (READ/WRITE)	006	014	022	030
SP Program in Progress, Run (READ/WRITE)	007	015	023	031

Configuration Parameters - UDC3000

Overview

Listed on the following pages are the identifying codes for the parameters in the various setup groups in the UDC 3000 controller. The table below lists the setup groups and the table number in which they are listed. Most of the parameters are configurable through the Host. Some are READ ONLY and are indicated as such and cannot be changed.

Setup Group	Table Number
TUNING	5-15
SP RAMP/PROG	5-16
ADAPTIVE	5-17
ALGORITHMS	5-18
INPUT 1	5-19
INPUT 2	5-20
CONTROL	5-21
OPTIONS	5-22
COMMUNICATIONS	5-23
ALARMS	5-24

Reading or Writing

Do a Read or Write (see "Read/Write Operations") depending on your requirements using the identifying code and format code listed in the tables. The range or selection available for each range is listed in the tables.

Continued on next page

Configuration Parameters - UDC3000, Continued

Tuning

Table 5-15 lists all the I.D. Codes and ranges or selection for the function parameters in the setup group "TUNING."

Table 5-15 Setup Group: Tuning

Parameter Description	Identifying Code	Format Code	Range or Selection
Heat Gain or PB	001	18	PB=0.1 to 9999% Gain=0.1 to 9999
Heat Rate	002	18	0.08 to 10.00 Minutes
Heat Reset or RPM	003	18	Reset=0.00 to 50.0 min/rpt RPM = 0.00 to 50.0 rpt/min
Manual Reset	013	18	-100 to +100% Output
Cool Gain/Gain #2 or PB	004	18	PB=0.1 to 9999% Gain=0.1 to 9999
Cool Rate/Rate #2	005	18	0.08 to 10.00 Minutes
Cool Rate/Reset #2 or RPM	006	18	Reset=0.00 to 50.0 min/rpt RPM = 0.00 to 50.0 rpt/min
Heat Cycle Time	158	11	2 to 120 Seconds
Cool Cycle Time	159	11	2 to 120 Seconds
Lockout Changes to data always possible via communication regardless of this configuration	132	11	0 = None 1 = Calibration 2 = +Configuration 3 = +View 4 = Maximum

Continued on next page

Configuration Parameters - UDC3000 Continued

Tuning, continued

Table 5-15 Setup Group: Tuning, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Keyboard Lockout	191	11	0 = All keys enabled 1 = Manual/Auto Key Locked 2 = Setpoint Select Key Locked 3 = Manual/Auto and Setpoint Select Keys Locked 4 = Run/Hold Key Locked 5 = Run/Hold Key and Manual/Auto Keys Locked 6 = Run/Hold Key and Setpoint Select Keys Locked 7 = Run/Hold, Setpoint Select, and Manual/Auto Keys Locked

Continued on next page

Configuration Parameters - UDC3000 Continued

Setpoint Ramp Rate/Program

Table 5-16 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "SP RAMP/RATE/PROGRAM."

Table 5-16 Setup Group: SP Ramp, Rate, or SP Program

Parameter Description	Identifying Code	Format Code	Range or Selection
Setpoint Program Ramp Selection	178	11	0 = SP Program, Rate, and Ramp Disabled 1 = SP Program Enabled 2 = SP Ramp Enabled 3 = SP Rate Enabled
SP Ramp			
Single SP Ramp Time	174	11	0 to 255 (Minutes)
Final Ramp SP Value	026	18	PV Range in Engineering Units
SP Rate			
Rate Up	88	18	0 to 9999
Rate Down	89	18	0 to 9999
***SP Program**			
Start Segment Number	175	11	1 to 11
End Segment Number (Soak)	176	11	2, 4, 6, 8, 10, or 12
Program Recycles	177	11	0 to 99
Guaranteed Soak Deviation	087	18	0 to 99.9 (0 = no soak)
Segment #1 Ramp Time	057	18	99.59 (0-99 Hrs : 0-59 Min) or 999 (0-999 Deg/Min)
Segment #2 Soak Setpoint Value	058	18	Within Setpoint Limits
Segment #2 Soak Time	059	18	99.59 (0-99 Hrs : 0-59 Min)
Segment #3 Ramp Time	060	18	99.59 (0-99 Hrs : 0-59 Min) or 999 (0-999 Deg/Min)

Continued on next page

Configuration Parameters - UDC3000, Continued

Setpoint Ramp/Rate/Program, continued

Table 5-16 Setup Group: SP Ramp, Rate, or SP Program, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Segment #4 Soak Setpoint Value	061	18	Within Setpoint Limits
Segment #4 Soak Time	062	18	99.59 (0-99 Hrs : 0-59 Min)
Segment #5 Ramp Time	063	18	99.59 (0-99 Hrs : 0-59 Min) or 999 (0-999 Deg/Min)
Segment #6 Soak Setpoint Value	064	18	Within Setpoint Limits
Segment #6 Soak Time	065	18	99.59 (0-99 Hrs : 0-59 Min)
Segment #7 Ramp Time	066	18	99.59 (0-99 Hrs : 0-59 Min) or 999 (0-999 Deg/Min)
Segment #8 Soak Setpoint Value	067	18	Within Setpoint Limits
Segment #8 Soak Time	068	18	99.59 (0-99 Hrs : 0-59 Min)
Segment #9 Ramp Time	069	18	99.59 (0-99 Hrs : 0-59 Min) or 999 (0-999 Deg/Min)
Segment #10 Soak Setpoint Value	070	18	Within Setpoint Limits
Segment #10 Soak Time	071	18	99.59 (0-99 Hrs : 0-59 Min)
Segment #11 Ramp Time	072	18	99.59 (0-99 Hrs : 0-59 Min) or 999 (0-999 Deg/Min)
Segment #12 Soak Setpoint Value	073	18	Within Setpoint Limits
Segment #12 Soak Time	074	18	99.59 (0-99 Hrs : 0-59 Min)
Program End State	181	11	0 = Disable SP Program 1 = Hold at Program End
Controller Status at Program End	180	11	0 = Last Setpoint 1 = Manual, Failsafe

Continued on next page

Setpoint Ramp Rate/Program, continued

Table 5-16 Setup Group: SP Ramp. Rate, or SP Program, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Engineering Units or Ramp Segments	182	11	0 = HRS:MIN 1 = Degrees/Minute
Present Segment Number	251	11	(READ ONLY)
Time Remaining — Minutes	252	11	(READ ONLY)
Time Remaining — Hours	253	11	(READ ONLY)
Cycles Remaining	254	11	(READ ONLY) Recycles—Elapsed Cycles

Continued on next page

Configuration Parameters - UDC3000, Continued

Adaptive tune

Table 5-17 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "ADAPTIVE TUNE."

Table 5-17 Setup Group: Adaptive Tune

Parameter Description	Identifying Code	Format Code	Range or Selection
Adaptive Tune Selection	152	11	Read only 0 = Disabled 3 = SP Tune
Setpoint Change	153	11	Read Only 5 to 15
Process Gain (KPG)	114	18	0.01 to 50.0
Adaptive Tune Error Codes	151	11	Read Only 0 = None 1 = Output > or < Output Limits or Manual Step = 0 2 = Output > or < Heat/Cool Limits 4 PV Changes Insufficient 5 = Process Identification failed 6 = Calculated Reset Outside Reset Limits 7 = Calculated Gain Outside Gain Limits 8 = Adaptive Tune Aborted on Command 9 = Input #1 Error Detected 10 = Adaptive Tune Illegal during Ramp/SP Program 11 = Adaptive Tune Aborted when External Switch Detected

Continued on next page

Configuration Parameters - UDC3000, Continued

Algorithm

Table 5-18 lists all the I.D. codes and ranges or selections for the function parameters in the setup group "ALGORITHM."

Table 5-18 Setup Group: Algorithm

Parameter Description	Identifying Code	Format Code	Range or Selection
Algorithm Selection	128	1	0 = ON/OFF 1 - PID-A 2 = PID-B 3 = PD-A with Manual Reset 4 = Three Position Step
Output Type	160	11	READ ONLY 0 = Not Allowed 1 = Position Proportional 2 = Relay Simplex 3 = Relay Duplex 4 = Current 5 = Current Duplex - Full Range* 6 = Relay/Current Duplex (relay on heat) 7 = Relay/Current duplex (relay on cool) *Current Duplex with split range on available with communications.

Continued on next page

Input 1

Table 5-19 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "Input 1."

Table 5-19 Setup Group: Input 1

Parameter Description	Identifying Code	Format Code	Range or Selection
Decimal Point Location	155	11	0 = XXXX Fixed 1 = XXX.X Floating DP with none 2 = XX.XX Fixed
Temperature Units	129	11	READ ONLY 0 = °F 1 = °C 2 = No Units
Input Type 1	168	11	READ ONLY 0 = B T/C 1 = E T/C H 2 = E T/C L 3 = J T/C H 4 = J T/C L 5 = K T/C H 6 = K T/C L 7 = N T/C H 8 = N T/C L 9 = R T/C 10 = S T/C 11 = T T/C H 12 = T T/C L 13 = W T/C H 14 = W T/C L 15 = 100 PLAT. 16 = 500 PLAT 17 = 100-LO 18 = 4-20 mA 19 = 0-10 mV 20 = 10-50 mA 21 = 1-5 Volts 22 = 0-10 Volts 23 = NIC T/C 24 = Radiamatic (RH)

Continued on next page

Input 1, continued

Table 5-19 Setup Group: Input 1, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Transmitter Characterization	169	11	READ ONLY 0 = B T/C 1 = E T/C H 2 = E T/C L 3 = J T/C H 4 = J T/C L 5 = K T/C H 6 = K T/C L 7 = N T/C H 8 = N T/C L 9 = R T/C 10 = S T/C 11 = T T/C H 12 = T T/C L 13 = W T/C H 14 = W T/C L 15 = 100 PLAT. 16 = 500 PLAT 17 = 100-LO 18 = LINEAR 19 = SQ ROOT 20 = NIC T/C 21 = Radiamatic (RH)
High Range Value	029	18	READ ONLY - For TC/RTD Types (In Engineering Units, T/C-RTD)
Low Range Value	030	18	READ ONLY-For TC/RTD Types (In Engineering Units, T/C-RTD)
Bias	107	18	-999.9 to 9999
Filter Time Constant	042	18	0 to 120 Seconds (No Filter = 0)
Burnout (Open Circuit Detection)	164	11	0 = None and Failsafe 1 = Upscale 2 = Downscale
Power Line Frequency	166	11	0 = 60 Hz 1 = 50 Hz
Emissivity	023	18	0.01 to 1.00

Continued on next page

Input 2

Table 5-20 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "INPUT 2."

Table 5-20 Setup Group: Input 2

Parameter Description	Identifying Code	Format Code	Range or Selection
Input Type	170	11	READ ONLY (18 = LINEAR)
Transmitter Characterization	171	11	READ ONLY 0 = B T/C 1 = E T/C H 2 = E T/C L 3 = J T/C H 4 = J T/C L 5 = K T/C H 6 = K T/C L 7 = N T/C H 8 = N T/C L 9 = R T/C 10 = S T/C 11 = T T/C H 12 = T T/C L 13 = W T/C H 14 = W T/C L 15 = 100 PLAT 16 = 500 PLAT 17 = 100-LO 18 = LINEAR 19 = SQ ROOT 20 = NIC T/C 21 = Radiamatic (RH)
High Range Value	035	18	READ ONLY (In Engineering Units)
Low Range Value	036	18	READ ONLY (In Engineering Units)
Filter Time Constant	043	18	0 to 120 Seconds (No Filter = 0)

Continued on next page

Control

Table 5-21 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "CONTROL."

Table 5-21 Setup Group: Control

Parameter Description	Identifying Code	Format Code	Range or Selection
Number of Tuning Sets	172	11	0 = One Set Only 1 = Two Sets (keyboard or communications 2 = Two Sets (Auto Switch PV) 3 = Two Sets (Auto Switch PV)
PV Switchover Value	056	18	Within the PV Range
Second Input Function	131	11	0 = Local Setpoint 1 = Remote Setpoint
Local Setpoint Select	173	11	000 = Local Setpoint #1 Only 001 = 2nd Local Setpoint via keyboard or communications*
Ratio	021	18	-20.00 to +20.00
Bias	022	18	-999 to +9999 in Engineering Units
LSP Tracking/ Power Up Output	138	11	0 = No 1 = Yes
Power Up Recall	130	11	0 = Manual—LSP 1 = Automatic—LSP 2 = Automatic—RSP 3 = Last Mode, Last Setpoint 4 = Last Mode, Last Local Setpoint
High Setpoint Limit	007	18	Within the PV Range (Engineering Units)
Low Setpoint Limit	008	18	Within the PV Range (Engineering Units)

Continued on next page

Control, continued

Table 5-21 Setup Group: Control, Continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Control Output Direction	135	11	0 = Direct 1 = Direct 2 = Reverse 3 = Reverse
Output Change Rate Limiting	189	11	0 = Disable 1 = Enable
Output Change Rate Up	090	18	1 to 9999 %/MIN
Output Change Rate Down	091	18	1 to 9999 %/MIN
High Output Limit	014	18	-5 to +105% of output
Low Output Limit	015	18	-5 to +105% of output
Output Dropoff Limit	020	18	-5 to +105% of output
Deadband	018	18	-5 to +25.0%
Output Hysteresis	019	18	0 to 5.0% of PV span
Failsafe Output Value	040	18	Within the Range of Output Limits
Proportional Band Units	148	11	0 = Gain 1 = Proportional Band
Reset Units	149	11	0 = Minutes 1 = Repeats per Minute

*I.D. Code 131—Second Input Function must be set to 0 (LSP).

Continued on next page

Options

Table 5-22 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "OPTIONS."

Table 5-22 Setup Group: Options

Parameter Description	Identifying Code	Format Code	Range or Selection
Digital Input #1	186	11	0 = None 1 = To Manual 2 = To Local Setpoint #1 3 = To Local Setpoint #2 4 = To Direct Action 5 = To Hold 6 = To PID 2 7 = PV = Input 2 8 = To Run 9 = Reset SP Program 10 = Inhibit PID Integral (I) Action 11 = To Manual Failsafe
Digital Input #2	187	11	Same as Digital Input #1 (Code 186)
Digital Input Status	188	11	0 = Digital Input 1 Open Digital Input 2 Open 1 = Digital Input 1 Closed Digital Input 2 Open 2 = Digital Input 1 Open Digital Input 2 Closed 3 = Digital Input 1 Closed Digital Input 2 Closed

Continued on next page

COMRS422

Table 5-23 lists all the I.D. Codes and ranges or selections for the function parameters in the setup group "COMRS422."

Table 5-23 Setup Group: COMRS422

Parameter Description	Identifying Code	Format Code	Range or Selection
Shed Time	154	11	0 to 255 Sample Periods 0 = No Shed
Shed Controller Mode and Output Level	162	11	0 = Last Mode and Last Output 1 = Manual Mode, Last Output 2 = Manual Mode, Failsafe Output 3 = Automatic Mode
Shed Setpoint Recall	163	11	0 = Use UDC Setpoint as determined by Remote/Local mode. LSP unchanged 1 = Use UDC Setpoint as determined by Remote/Local mode. LPS = Last setpoint prior to shed
Communication Units	161	11	0 = Percent (%) 1 = Engineering Units

Continued on next page

Alarms

Table 5-24 lists all the I.D. Codes and ranges or selections for the function parameter in the setup group "ALARMS."

Table 5-24 Setup Group: Alarms

Parameter Description	Identifying Code	Format Code	Range or Selection
Alarm #1 SP #1 Value	009	18	Value in Engineering Units
Alarm #1 SP #2 Value	010	18	Value in Engineering Units
Alarm #2 SP #1 Value	011	18	Value in Engineering Units
Alarm #2 SP #2 Value	012	18	Value in Engineering Units
Alarm #1 SP #1 Type	140	11	0 = None 1 = Input 1 2 = Input 2 3 = PV 4 = Deviation 5 = Output 6 = Alarm on Shed 7 = SP Event ON 8 = SP Event OFF
Alarm #1 SP #2 Type	142	11	Same as Code 140
Alarm #2 SP #1 Type	144	11	Same as Code 140
Alarm #2 SP #2 Type	146	11	Same as Code 140
Alarm #1 SP #1 State	141	11	0 = Low Alarm 1 = High Alarm
Alarm #1 SP #2 State	143	11	0 = Low Alarm 1 = High Alarm
Alarm #2 SP #1 State	145	11	0 = Low Alarm 1 = High Alarm
Alarm #2 SP #2 State	147	11	0 = Low Alarm 1 = High Alarm
Alarm Hysteresis	041	18	0 to 5.0% of full span or full output

Section 6 – Read, Write and Override Parameters on UDC 5000 ULTRA-PRO Controllers

Overview

Introduction

This section contains information concerning reading, writing, and overriding parameters on the UDC 5000 Ultra-Pro Controller. There are two types of parameters:

- Data Transfer—these parameters include reading control data, option status, and reading or changing setpoints or outputs.
- Configuration Data—all the configuration data is list in the order in which it appears in the controller.

Each type of parameter has the identifying codes listed with it. Follow the message exchange rules listed in "Read and Write Operations."

Continued on next page

Overview - UDC5000, Continued

What's in this section

This section contains the following topics:

Continued on next page

Overview - UDC5000, Continued

General Information

Analog Parameters

- Whenever Analog Parameters 001 through 114 (those that can be changed via Communications) are changed, a write cycle occurs immediately after receipt of the message.

Override Parameters

- Override Analog Parameters 120, 123 and 125 (PV, output, computer setpoint) are not stored in non-volatile memory and can be changed as frequently as desired with no effect on non-volatile memory retentivity, but controller must remain in slave mode.

Digital Parameters

- Whenever digital configuration parameters 128 through 250 are updated via communications, the non-volatile memory is updated as soon as the message is received.

Reading Control Data - UDC5000

Overview

You can Read the following control data from the UDC controller.

- Input 1
- Input 2
- Input 3
- PV
- Internal RV
- PV, Setpoint, Output

I.D. codes

Use the identifying codes listed in Table 6-1 to read the specific items.

A Write request for these Codes will result in an Error message.

Table 6-1 Control Data Parameters

Parameter Description	Identifying Code	Format Code	Range or Selection
Input #1	118	18	In Engineering Units or Percentage
Input #2	119	18	In Engineering Units or Percentage
Input #3	117	18	In Engineering Units or Percentage
PV	120	18	In Engineering Units or Percentage
Internal RV	121	18	In Engineering Units or Percentage
PV, Setpoint, and Output*	122	18	In Engineering Units or Percentage

*This Read request will give a three variable response (see Read/Write operation).

Option Status - UDC5000

Read

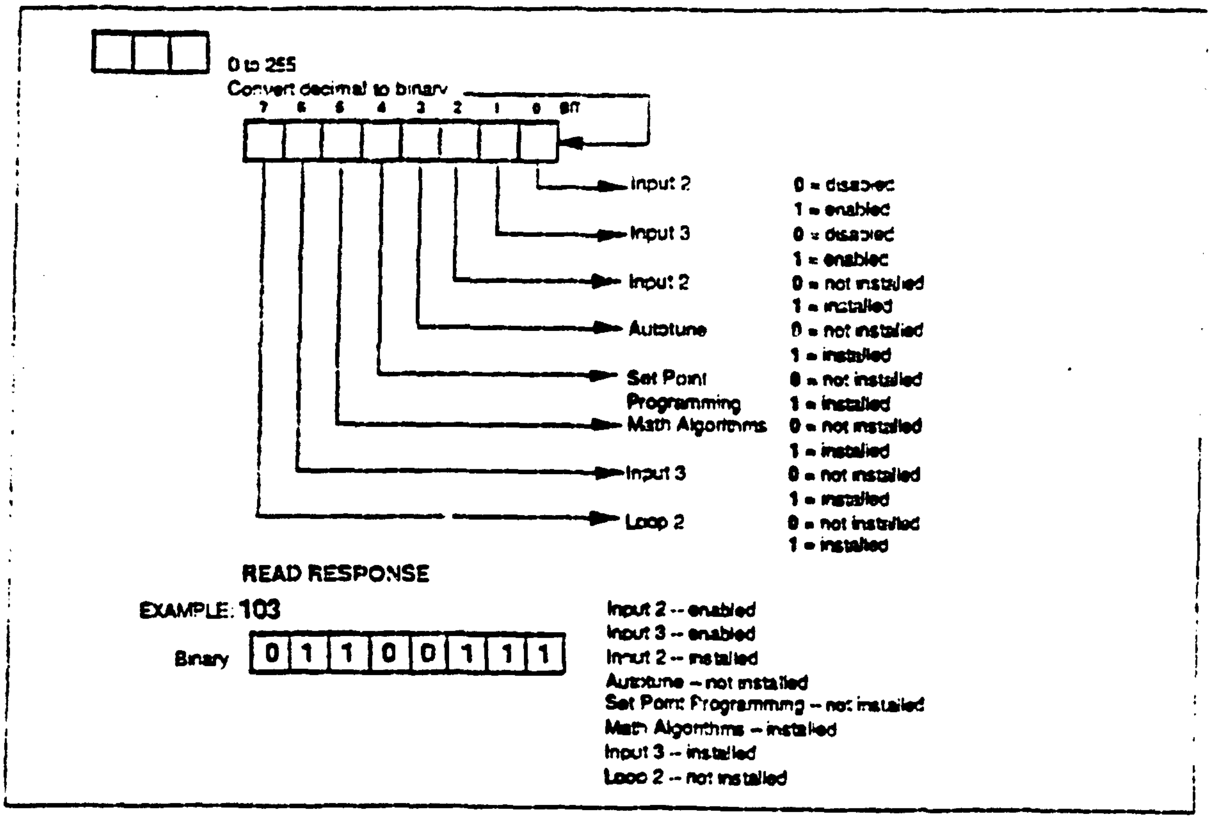
Doing a Read of I.D. Code 185 listed in Table 6-2 will tell you which of the available options are enabled/installed or disabled/not installed.

Table 6-2 Option Status

Parameter Description	Identifying Code	Format Code	Range or Selection
Option Status (read only)	185	11	See Figure 6-1

The data field in the response message will be a decimal number from 0 to 255. Convert the decimal number to binary as shown in Figure 6-1 to determine which options are or are not active.

Figure 6-1 Option Status Information



Write

A limited Write is available with which you can enable/disable Input 3. Change bit 0 or 1 as shown in Figure 6-1 and write the decimal designation to Code 185.

EXAMPLE: Disable Input 3—Write 101

Miscellaneous Read Only's - UDC5000

I.D. Codes for read only's

The identifying codes listed in Table 6-3 represent some parameters that are Read only. No Writes allowed.

Table 6-3 Miscellaneous Read Only's

Parameter Description	Identifying Code	Format Code	Range or Selection
Software Type	157	11	Read only (UDC 5000) 61 = Basic software 62 = Field upgrade for Autotune - Input 3 63 = Field upgrade for Autotune + Math + SPP + Input 3 64 = Field upgrade for Autotune + Input 3 + 2 Loop 65 = Field Upgrade has all options
Software Version (Read only)	167	11	0 to 99
Digital Input Switch Status (Read only)	190	11	0 = Switch #1 open Switch #2 open 1 = Switch #1 closed Switch #2 open 2 = Switch #1 open Switch #2 closed 3 = Switch #1 closed Switch #2 closed
UDC Error Status (Definitions are listed in Table 6-4)	255	11	See below Read/Write* 001 = Emergency Manual 002 = Failsafe 004 = Working Calibration Checksum Error 008 = Configuration Checksum Error 016 = Parameter Limit Indicator 032 = Hardware Failure 064 = Restart after Shed 128 = Configuration/Calibration Memory Changed * Write to clear.

Continued on next page

Miscellaneous Read Only's - UDC5000, Continued

I.D. Codes for read only's, continued

ATTENTION Any checksum error reported can only be cleared via keyboard/display viewing of the Status group (recalculates all checksums at least parameter.)

FOR EXAMPLE: If read returns 192 (restart after shed-064 plus configuration change -128)

Write anything to I.D. Code 255

Read returns 000 (clear)

Error status definitions Table 6-4 lists the UDC error status codes and their definitions

Table 6-4 Error Status Definitions

Status Code	Error	Definitions
001	Emergency Manual	Indicates that the output of the unit which has been in slave operation, is under manual control, locally. Error remains until local control is relinquished at the controller.
002	Failsafe	Error occurs whenever the control reverts to failsafe operation and remains as long as the condition exists.
004	Working Calibration Checksum Error	Indicates that an error exists in the working calibration data. Re-select the inputs to load factory calibration data or field calibrate the inputs.
008	Configuration Checksum Error	Error exists in the configuration data. Verify configuration data at the keyboard. Checksum will be recomputed by stepping the controller through the status tests.
016	Parameter Limit Indicator	A limit condition exists on one of the following: PV, RV, Input 1, Input 2, Input 3, Computer Setpoint. User must determine EXACT limit condition and correct.
032	Hardware Failure	Indicates either a RAM test failure or Input 1, Input 2, Input 3 failure on two consecutive conversions.
064	Restart After Shed	Error occurs whenever a shed of slave override is performed. Error is reset following a Write command to I.D. Code 255 (064).
128	Configuration /Calibration Memory Changed	Error occurs whenever shed, configuration, or calibration changed. Also occurs whenever there is a change of state in 001, 002, 004, 008, or 016. Error is reset following a Write command to I.D. Code 255.

Setpoints - UDC5000

Overview

You can use three separate setpoints in the UDC Controller. The identifying codes listed in Table 6-5 allow you to select which setpoint you want to use and to enter a value in Engineering Units or Percent (whichever is selected at Code 161) for that setpoint via communications.

I.D. codes

Make your selection using I.D. Code 173 and enter the value for the setpoint chosen using I.D. Code 39 (SP1) or 53 (SP2) or 113 (SP3).

Table 6-5 Setpoint Code Selections

Parameter Description	Identifying Code	Format Code	Range or Selection
Local Setpoint #1	039	18	Value within the setpoint range limits
Local Setpoint #2	053	18	Value within the setpoint range limits
Local Setpoint #3	113	18	Value within the setpoint range limits
Local Setpoint Select	173	11	000 = Local Setpoint #1 only 001 = 2nd Local Setpoint via keyboard or communications 003 = 3rd Local Setpoint via keyboard or communications

Associated parameters

Refer to Table 6-6 for the codes required to display or change any of the parameters associated with the setpoint.

Table 6-6 Setpoint Associated Parameters

Parameter	Code
Setpoint Limits	007, 008
Computer Setpoint	125

Using a Computer Setpoint (Overriding Controller Setpoint) - UDC5000

Overview

You can use a setpoint generated from the computer to override the setpoint being used by the controller.

The value generated by the computer will have Ratio and Bias applied by the controller.

I.D. Codes

Use the identifying code in Table 6-7 to enter the computer setpoint.

Table 6-7 Computer Setpoint Selections

Parameter Description	Identifying Code	Format Code	Range or Selection
Computer Setpoint	125	18	Within the Setpoint Range Limits in Engineering Units or Percent

Shed

The Computer Setpoint Override will continue until "SHED" from Communications occurs or the controller is placed into monitor mode through communications. Doing periodic "SLAVE READS" within the shed time will allow the override to continue until communication is stopped and Shed Time elapses.

ATTENTION 0 Shed (code 154) allows the Override to continue indefinitely or until the Override is cancelled. (See Override selection I.D. Code 183.)

When SP is overridden, the left most digit in the upper display becomes a "C."

Continued on next page

Using a Computer Setpoint (Overriding Controller Setpoint)- UDC5000, Continued

Associated Parameters Refer to Table 6-8 for the codes required to display or change any of the parameters associated with the computer setpoint.

Table 6-8 Computer Setpoint: Associated Parameters

Parameter	Code
Setpoint Limits	007, 008
Local Setpoint #1	039
Local Setpoint #2	053
Local Setpoint #3	113
Local Setpoint Selection	173

Overriding the Inputs - UDC5000

Overview

You can override any of the three input values in the controller using the codes listed in Table 6-9.

Table 6-9 Input Override Codes

Parameter Description	Identifying Code	Format Code	Range or Selection
Override Input 1	124	18	Within the input limits in engineering units or percent (whichever is selected at I.D. Code 161)
Override Input 2	115	18	Within the input limits in engineering units or percent (whichever is selected at I.D. Code 161)
Override Input 3	116	18	Within the input limits in engineering units or percent (whichever is selected at I.D. Code 161)

Shed

The override to the input will continue until "SHED" from Communications occurs or the controller is placed into monitor via communications. Doing Reads within the shed time will let the override continue until Reads are stopped and SHED time elapses (I.D. Code 154).

ATTENTION 0 shed time (Code 154) lets the override continue indefinitely or until override is cancelled. (See I.D. Code 183.)

Continued on next page

Overriding the Inputs - UDC5000, Continued

Associated Parameters

Refer to Table 6-10 for the codes required to display or change any of the parameters associated with the inputs.

Table 6-10 Input Override Associated Parameters

Parameter	Code
High/Low Range Values	
Input 1	029/030
Input 2	035/036
Input 3	108/109
Temperature Units	129
Input Type	
Input 1	168
Input 2	170
Input 3	186
Transmitter Characterization	
Input 1	169
Input 2	171
Input 3	187
Bias	
Input 1	107
Input 2	137
Input 3	111
Filter Time Constant	
Input 1	042
Input 2	043
Input 3	112
Burnout	
Input 1	164
Input 2	165

PV, Setpoint, or Input Override Status or Cancellation - UDC5000

Overview

You can Read the present override status of the inputs, PV, or setpoint or you can do a Write transaction to cancel an existing override.

I.D. Codes

Use the Identifying Code in Table 6-11 to Read or Write your selection.

Table 6-11 PV, Setpoint, or Input Override Cancellation

Parameter Description	Identifying Code	Format Code	Range or Selection
PV or Setpoint Override Selection	183	11	01 = Input 1 02 = Input 2 04 = PV 08 = Setpoint 16 = Input 3

Reading or Changing the Output - UDC5000

Overview

You can read the output of a particular UDC controller (Read transaction) or you can change it to suit your needs. (Do a Write transaction.)

I.D. Codes

Use the identifying code in Table 6-12 to monitor (Read) or change (Write) the output (in manual only).

ATTENTION To Write (change) the output, the controller must first be in manual mode.

Table 6-12 Reading or Changing the Output

Parameter Description	Identifying Code	Format Code	Range or Selection
Output	123	16	-5 to +105% of full span (current output) 0 to 100% (relay type output)

Associated Parameters

Refer to Table 6-13 for the codes required to display or change any of the parameters associated with the output.

Table 6-13 Associated Output Codes

Parameter	Code
Output Limits	014, 015
Output Dropoff Limits	020
Failsafe Output Values	040
Output Deadband	018
Output Hysteresis	019
Output Type	160

Local Setpoint/PID Selection /Setpoint Ramp Status - UDC5000

Overview

Identifying Code 250 lets you

- Monitor your Setpoint Ramp Status
  - In Progress, Not in Progress
  - In Run, On Hold (see Note 1)

  and determine which tuning set and local setpoint is being used.
- Abort, Run, Hold, or Start and SP Ramp.
- Select Local Setpoint #1, #2, or #3.
- Select Tuning Parameter Set #1 or #2.

Read

When you do a Read, the code in Table 6-14 determines which parameters are active:

- Local Setpoint Selection
- Tuning Parameter Set Selection
- Setpoint Ramp Status

Table 6-14 I.D. Code 250 Reads

Parameter Description	Identifying Code	Format Code	Range or Selection
Read Local Set Point/PID Set Selection and SP Ramp Status	250	11	See Figure 6-2

Continued on next page

Local Setpoint/PID Selection /Setpoint Ramp Status - UDC5000, Continued

Read, continued

Figure 6-2 I.D. Code 250 Indications

SET POINT RAMP INFORMATION	Tuning Set #1 Selection, Local Set Point #1 Selection	Tuning Set #1 Selection, Local Set Point #2 Selection	Tuning Set #2 Selection, Local Set Point #1 Selection	Tuning Set #2 Selection, Local Set Point #2 Selection	Tuning Set #1 Selection, Local Set Point #3 Selection	Tuning Set #2 Selection, Local Set Point #3 Selection
SP Ramp, Enabled not in progress (Read only)	000	008	016	024	032	048
SP Ramp in progress, Hold (Read/Write)	002	010	018	026	034	050
SP Ramp in progress, Run (Read/Write)	003	011	019	027	035	051
SP Program, Enabled not in progress (Read only)	004	012	020	028	036	052
SP Program in progress, Hold (Read/Write)	006	014	022	030	038	054
SP Program in Progress, Run (Read/Write)	007	015	023	031	039	055

Write

A Write of code 250 lets you change the SP ramp status as well as the local setpoint or tuning set selection. Refer to Table 6-15.

Table 6-15 I.D. Code 250 Writes

Parameter Description	Identifying Code	Format Code	Range or Selection
Write	250	11	000 = Abort SP Ramp
			001 = Run SP Ramp
Local Setpoint/PID Set Selection and SP Ramp Status			002 = Hold SP Ramp
			003 = Start SP Ramp
			004 = Change to Local Setpoint #1
			005 = Change to Local Setpoint #2
			006 = Change to PID Tuning Set #1
			007 = Change to PID Tuning Set #2
			008 = Change to Local Setpoint #3

ATTENTION To enable or disable the setpoint ramp, refer to identifying Code 150.

Configuration Parameters - UDC5000

Overview

Listed on the next pages are the Identifying codes for the parameters in the various Setup groups in the UDC 5000 Ultra-Pro controller. The table below lists the Setup Groups and their table numbers in which they are listed. Most of the parameters are configurable through the host. Some are Read Only and are indicated as such and cannot be changed.

Setup Group	Table Number
TUNING	6-16
TUNING L2	6-17
SP RAMP/PROGRAM	6-18
AUTOTUNE/ADAPTIVE TUNE	6-20
ALGORITHM	6-21
OUTPUT ALGORITHM	6-22
INPUT 1	6-23
INPUT 2	6-24
INPUT 3	6-25
CONTROL AND CONTROL 2	6-26
OPTIONS	6-27
COMMUNICATIONS	6-28
ALARMS	6-29
DISPLAY	6-30

Reading or writing

Do a Read or Write (see "Read/Write Operations"), depending on your requirements using the identifying code and format code listed in the tables. The range or selection available for each range is listed in the tables.

Continued on next page

Configuration Parameters - UDC5000, Continued

Tuning

Table 6-16 lists all the I.D. codes and ranges or selections for the function parameters in the Setup Group "TUNING" (Loop 1).

Table 6-16 Setup Group: Tuning (Loop 1)*

Parameter Description	Identifying Code	Format Code	Range or Selection
Gain #1 or PB	001	18	0.1 to 1000
Rate #1	002	18	0.00 to 10.00
Reset #1	003	18	0.02 to 50.00
Manual Reset	013	18	-100 to +100
Gain #2 or PB	004	18	0.1 to 1000
Rate #2	005	18	0.00 to 10.00
Reset #2	006	18	0.02 to 50.00
Cycle Time #1	158	11	1 to 120 seconds
Cycle Time #2	159	11	1 to 120 seconds
Lockout (keyboard only) Changes to data always possible via communications regardless of this configuration.	132	11	0 = None 1 = Calibration + Configuration 2 = Max Lockout 3 = Calibration only 4 = Calibration + Configuration + View

* Loop selected by address in request message.

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Configuration Parameters - UDC5000, Continued

Tuning 2

Table 6-17 lists all the I.D. codes and ranges or selections for the function parameters in the Setup Group "TUNING 2 (Loop 2)."

Table 6-17 Setup Group: Tuning 2* (Loop 2)

Parameter Description	Identifying Code	Format Code	Range or Selection
Gain #3 or PB	001	18	0.1 to 1000
Rate #3	002	18	0.00 to 10.00
Reset #3	003	18	0.02 to 50.00
Man 3 Reset	013	18	–100 to +100
Gain #4 or PB	004	18	0.1 to 1000
Rate #4	005	18	0.00 to 10.00
Reset #4	006	18	0.02 to 50.00
Cycle Time #3	158	11	1 to 120 seconds
Cycle Time #4	159	11	1 to 120 seconds

* Loop selected by address in request message.

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Configuration Parameters - UDC5000, Continued

SP ramp/program

Table 6-18 lists all the I.D. codes and ranges or selections for the function parameters in setup group "SP RAMP."

Table 6-18 Setup Group: Setpoint Ramp/Program

Parameter Description	Identifying Code	Format Code	Range or Selection
Setpoint Program/Ramp Selection	178	11	0 = SP Program and Ramp disabled 1 = SP Program enabled 2 = SP Ramp enabled 3 = SP Program enabled–Loop 2 4 = SP Program enabled–both loops 5 = SP Ramp enabled–Loop 2 6 = SP Ramp enabled–both loops
SP RAMP Setpoint Ramp Loop Enable	150	11	0 = OFF 2 = SP Ramp – enabled Loop 1 3 = SP Ramp – enabled Loop 2 4 = SP Ramp – enabled both loops
Single SP Ramp Time	174	11	0 to 255 (minutes) applies to whichever loop has SP Ramp configured
Final Ramp SP Value	026	18	PV Range in Engineering Units
SP PROGRAM Start Segment No.*	175	11	1 to 19
End Segment No. (Soak)*	176	11	2, 4, 6, 8, 10, 12 14, 16, 18, 20
No. of Recycles*	177	11	0 to 99

Continued on next page

SP ramp/program, continued

Table 6-18 Setup Group: Setpoint Ramp/Program, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Program Status at Power Up from Power Outage*	179	11	0 = *Abort* program on reset 1 = *Resume* program at last segment and last segment time 2 = *Restart*
Controller Status at Program End*	180	11	0 = Hold at last setpoint in program 1 = Manual mode failsafe output
Controller State at Program End*	181	11	0 = Disables SP program 1 = Hold–Run key restarts SP program
Engineering Units for Ramp Segments*	182	11	0 = HRS:MIN 1 = Degrees/minute
Guaranteed Soak Enable*	184	11	0 = Enable 1 = Disable
Present Segment No.*	251	11	(Read only) 1 to 20
Time Remaining Minutes*	252	11	(Read only) 0 to 59
Time Remaining Hours*	253	11	(Read only) 0 to 99
Cycles Remaining*	254	11	(Read only) 0 to 99 recycles–elapsed cycles
Segment Ramp Time	See Table 6-17	18	99.59 (0-99 hrs: 0-59 min) 999 (0-999 deg/min)
Segment Soak Setpoint Value	See Table 6-17	18	Within setpoint limits
Segment Soak Time	See Table 6-17	18	99.59 (0-99 hrs: 0-59 min)
Segment Guaranteed Soak Deviation + (Plus)	See Table 6-17	18	0 to 99.99
Segment Guaranteed Soak Deviation – (Minus)	See Table 6-17	18	0 to 99.99

*Applies to whichever loop has Setpoint Program applied to it.

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Ramp and soak I.D.codes for each segment

Table 6-19 Lists each segment and the I.D. code associated with ramp and soak information for each particular segment.

Table 6-19 Setpoint Program Ramp and Soak Identifying Codes for Each Segment

Segment Number	Identifying Codes				
	Ramp Time	Soak Setpoint Value	Soak Time	Guaranteed Soak Deviation (Plus)	Guaranteed Soak Deviation (Minus)
1	057	—	—	—	—
2	—	058	059	087	088
3	060	—	—	—	—
4	—	061	062	089	090
5	063	—	—	—	—
6	—	064	065	091	092
7	066	—	—	—	—
8	—	067	068	093	094
9	069	—	—	—	—
10	—	070	071	095	096
11	072	—	—	—	—
12	—	073	074	097	098
13	075	—	—	—	—
14	—	076	077	099	100
15	078	—	—	—	—
16	—	079	080	101	102
17	081	—	—	—	—
18	—	082	083	103	104
19	084	—	—	—	—
20	—	085	086	105	106

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Configuration Parameters - UDC5000, Continued

Autotune/adaptive tune

Table 6-20 lists all the I.D. codes and ranges or selections for the function parameters in setup group "AUTOTUNE/ADAPTIVE TUNE." Loop 1 or 2 is selected in the request message.

Table 6-20 Setup Group: Autotune/Adaptive Tune

Parameter Description	Identifying Code	Format Code	Range or Selection
Autotune/ Adaptive Tune Selection	152	11	**0** = Autotune and adaptive tune disabled – Loop 1 **1** = Exponential response – Loop 1** **2** = Critically damped – moderate – Loop 1** **3** = Critically damped – fast – Loop 1* **4** = Auto step – Loop 1 **5** = Manual step – Loop 2 **6** = Auto step – Loop 2 **7** = Adaptive SP – Loop 1 **8** = Adaptive SP + PV – Loop 1
Adaptive Tune Selection (Loop 2 only) NOTE: Loop 1 I.D. Code 152 must not be configured for any Autotune: i.e. Autotune and Adaptive are mutually exclusive.	152	11	**0** = Disabled **1** = Adaptive setpoint **2** = Adaptive SP + PV
Autotune Step Size/Adaptive SP Change Size (Loop 1 only)	153	11	Step size/5 to 15% span SP change/–100 to +100
Process Gain (Loop 1 only)	114	18	0.01 to 50.0

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Autotune/adaptive tune, continued

Table 6-20 Setup Group: Autotune/Adaptive Tune, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Adaptive Tune Error (Read only)	151	11	**0** = None **1** = Output less than or greater than Output Limits or Man Step = 0 **2** = Output greater or less than Heat/Cool Limits **3** = Alarm 1 error **4** = PV change not sufficient **5** = Process Identification failed **6** = Calculated Reset outside Reset Limits **7** = Calculated Gain outside Gain Limits **8** = Adaptive tune/ Autotune aborted on command **9** = Input 1 error detected **10** = Adaptive Tune/ Autotune illegal during Ramp/Program **11** = Adaptive Tune/ Autotune aborted when external switch detected

**Selections 1 and 2 will internally default to the #3 selection.

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Configuration Parameters - UDC5000, Continued

Algorithm

Table 6-21 lists all the I.D. codes and ranges or selections the function parameters in setup group "ALGORITHM." Loop 1 or 2 selected in the request message.

Table 6-21 Setup Group: Algorithm

Parameter Description	Identifying Code	Format Code	Range or Selection
Control Algorithm Selection *not available for Loop 2	128	11	**0** = ON-OFF* **1** = PID-A **2** = PID-B **3** = PD-A with manual reset **4** = Three position step*
Loop 2 Selection (Loop 2 address only)	168	11	**0** = Loop 1 only **1** = Loop 2 enabled **2** = Loop 1 and 2 are cascaded. Loop 2 primary – Loop 1 secondary
Output Override Hi or Lo Select (on Loop 2 address only – Loop 1 Output in Auto)	136	11	**0** = Disabled **1** = Hi Select **2** = Lo Select

Continued on next page

Algorithm, continued

Table 6-21 Setup Group: Algorithm, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Second Input Function NOTE: Any selection except 0 may affect the Third Input Function (ID Code #188) All selections available for Loop 1. Selections 0, 1 and 2 only selections available for Loop 2. All others result in error message	131	11	**0** = Local setpoint **1** = Remote setpoint with ratio **2** = Remote setpoint with ratio and bias (auto bias) **3** = Weighted average (LSP) **4** = Relative humidity (LSP) **5** = Carbon potential A (LSP) **6** = Carbon potential B (LSP) **7** = Carbon potential C (LSP) **8** = Feed forward (Loop 1) **9** = Add inputs 1 and 2 - without ratio and bias **10** = Subtract input 2 from input 1 – without ratio and bias **11** = Input high select (without ratio and bias) **12** = Input low select (without ratio and bias) **13** = General math A (sq. rt. mult. div.) **14** = General math B (sq. rt. mult.) **15** = General math C (mult. div.) **16** = General math D (mult.) **17** = Summer (with ratio and bias) **18** = Input hi select (with ratio and bias)

Continued on next page

Configuration Parameters - UDC5000, Continued

Algorithm, continued

Table 6-21 Setup Group: Algorithm, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Second Input Function (continued)	131	11	**19** = Input low select (with ratio and bias) **20** = Feedforward – Loop 2 **21** = Carbon potential D (LSP) **22** = Carbon potential FCC (LSP) **23** = % oxygen **24** = Dewpoint
Atmospheric Pressure	024	18	590.0 to 760.0
Percent Co	046	18	0.02 to 0.350
Constant K	045	18	0 to 20.00
Input 3 Function NOTES: When 2nd input function (ID 131) is 1 or 2, input 3 function cannot be selection 1 or 2. **When 2nd input function (ID 131) is 3 or greater, input 3 function cannot be selection 3 through 7.**	188	11	**0** = None **1** = Remote setpoint (with ratio) **2** = Remote setpoint (with ratio and bias) auto bias **3** = Feed forward (with ratio and bias) **4** = Sums input 143* (with ratio and bias) **5** = Input high select* (with ratio and bias) **6** = Input low select* (with ratio and bias)
PV High	054	18	–999 to +9999 in engineering units (Read only on loop 2)
PV Low	055	18	–999 to +9999 in engineering units (Read only on loop 2)

* Not available on Loop 2.

Continued on next page

Configuration Parameters - UDC5000, Continued

Output algorithm

Table 6-22 lists all the I.D. codes and ranges or selections the function parameters in setup group "OUTPUT ALGORITHM." Loop 1 or 2 selected by address in the request message.

Table 6-22 Setup Group: Output Algorithm

Parameter Description	Identifying Code	Format Code	Range or Selection
Output Algorithm	160	11	0 = None (loop 1) – disabled (loop 2) 1 = Position proportional (loop 1 only) 2 = Relay simplex 3 = Relay duplex (loop 1 only) 4 = Current 5 = Current duplex 6 = Relay/current (relay-heat, current-full) 7 = Relay/current (relay-cool, current-full) 8 = Current duplex (current out-cool, aux. out-heat) 9 = Relay/current (relay heat, current split) loop 1 only 10 = Relay/current (relay-cool, current-split) loop 1 only
Duplex Relay State at 0% Output (on Loop 1 address only)	136	11	0 = Relay 1-de-energized Relay 2-de-energized 1 = Relay 1-energized Relay 2-de-energized 2 = Relay 1-de-energized Relay 2-energized 3 = Relay 1-energized Relay 2-energized

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Configuration Parameters - UDC5000, Continued

Input 1

Table 6-23 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 1."

Table 6-23 Setup Group: Input 1 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 1 Type	168	11	**0** = B T/C**
			1 = E T/C high
			2 = J T/C high
			3 = K T/C high
			4 = Ni-Ni-Moly T/C high
			5 = R T/C
			6 = S T/C
			7 = T T/C high
			8 = W T/C high
			11 = Nicrosil Nisil T/C
			12 = 100 ohm plt RTD
			13 = 100 ohm plt RTD R– 21-212°F range
			14 = 200 ohm plt RTD
			15 = 500 ohm plt RTD
			19 = Radiamatic
			22 = 0-20/4-20 mA
			23 = 0-10 mV
			24 = 10-50 mV
			25 = 1-5 volts
			26 = 0-10 volts
			30 = E T/C low
			31 = J T/C low
			32 = K T/C low
			33 = Ni-Ni-Moly T/C low

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Configuration Parameters - UDC5000, Continued

Input 1, continued

Table 6-23 Setup Group: Input 1 (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 1 Type, continued	168	11	**34** = T T/C low **35** = W T/C lo **36** = 100 ohm plt RTD low
Input 1 Transmitter Characterization NOTE: Applicable when ID Code 168 equals 22, 23, 24, 25, or 26.	169	11	**0** = B T/C **1** = E T/C high **2** = J T/C high **3** = K T/C high **4** = Ni-Ni-Moly T/C high **5** = R T/C **6** = S T/C **7** = T T/C high **8** = W T/C high **11** = Nicrosil-Nisil T/C **12** = 100 plt RTD **13** = Plt RTD RH 21-212°F range **19** = Linear **20** = Square root **21** = E T/C low **22** = J T/C low **23** = K T/C low **24** = -Ni-Moly T/C low **25** = T T/C low **26** = W T/C low **27** = 100 ohm plt RTD low **28** = 200 ohm plt RTD **29** = 500 ohm plt RTD
Input 1 High Range Value	029	18	–999. to 9999. engineering units
Input 1 Low Range Value	030	18	–999 to 9999. engineering units

Continued on next page

Input 1, continued

Table 6-23 Setup Group: Input 1 (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 1 Bias	107	18	−999 to 9999. engineering units
Input 1 Filter	042	18	0 to 120 seconds
Input 1 Burnout	164	11	0 = None and failsafe 1 = Upscale 2 = Downscale
Input 1 Emissivity	023	18	0.01 to 1.00

*T/C = thermocouple

Input 2

Table 6-24 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 2."

Table 6-24 Setup Group: Input 2 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 2 Type	170	11	0 = B T/C* 1 = E T/C high 2 = J T/C high 3 = K T/C high 4 = Ni-Ni-Moly T/C high 5 = R T/C 6 = S T/C 7 = T T/C high 8 = W T/C high 11 = Nicrosil Nisil T/C 12 = 100 ohm plt RTD 13 = 100 ohm plt RTD RH 21-212°F range 14 = 200 ohm plt RTD

Continued on next page

Configuration Parameters - UDC5000, Continued

Input 2, continued

Table 6-24 Setup Group: Input 2 (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 2 Type, continued	170	11	15 = 500 ohm plt RTD 19 = Radiamatic 22 = 0-20/4-20 mA 23 = 0-10 mV 24 = 10-50 mV 25 = 1-5 volts 26 = 0-10 volts 28 = Carbon sensor 29 = Oxygen 30 = E T/C low 31 = J T/C low 32 = K T/C low 33 = Ni-Ni-Moly T/C low 34 = T T/C low 35 = W T/C lo 36 = 100 ohm plt RTD low
Input 2 Transmitter Characterization NOTE: Applicable when ID Code 170 equals 22, 23, 24, 25, or 26.	171	11	0 = B T/C** 1 = E T/C high 2 = J T/C high 3 = K T/C high 4 = Ni-Ni-Moly T/C high 5 = R T/C 6 = S T/C 7 = T T/C high 8 = W T/C high 11 = Nicrosil-Nisil T/C 12 = 100 plt RTD 13 = Plt RTD RH 21-212°F range

Continued on next page

Input 2, continued

Table 6-24 Setup Group: Input 2 (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 2 Transmitter Characterization, continued NOTE. Applicable when ID Code 170 equals 22, 23, 24, 25, or 26.	171	11	19 = Linear 20 = Square root 21 = E T/C low 22 = J T/C low 23 = K T/C low 24 = Ni-Ni-Moly T/C low 25 = T T/C low 26 = W T/C low 27 = 100 ohm pt RTD low 28 = 200 ohm pt RTD 29 = 500 ohm pt RTD
Input 2 High Range Value	035	18	–999. to 9999 Engineering Units
Input 2 Low Range Value	036	18	–999 to 9999 Engineering Units
Input 2 Bias	037	18	–999 to 9999. Engineering Units
Input 2 Filter	043	18	0 to 120 seconds
Input 2 Burnout	165	11	0 = None and failsafe 1 = Upscale 2 = Downscale
Input 2 Emissivity	044	18	0.01 to 1.00

*T/C = thermocouple

Continued on next page

Input 3

Table 6-25 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 3."

Table 6-25 Setup Group: Input 3 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 3 Type	186	11	0 = OFF 19 = Linear NOTE: If 0 is received as a write, the input is disabled and the transmitter selection is lost. Whenever 19 is received as a write, if the input was previously disabled, the transmitter selection is set to linear with a range indeterminate; however, if the input was previously enabled, the transmitter type is unchanged.
Input 3 Transmitter Characterization	187	11	0 = B T/C 1 = E T/C high 2 = J T/C high 3 = K T/C high 4 = Ni-Ni-Moly T/C high 5 = R T/C 6 = S T/C 7 = T T/C high 8 = W T/C high 11 = Nicrosil Nisil T/C 12 = 100 ohm plt RTD 19 = Linear 20 = Square root 21 = E T/C low 22 = J T/C low 23 = K T/C low 24 = Ni-Ni-Moly T/C low 25 = T T/C low 26 = W T/C low 27 = 100 ohm plt RTD low 28 = 200 ohm plt RTD 29 = 500 ohm plt RTD
Input 3 High Range Value	106	18	−999. to 9999. Engineering Units

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Configuration Parameters - UDC5000, Continued

Input 3, continued

Table 6-25 Setup Group: Input 3 (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 3 Low Range Value	109	18	-999 to 9999, Engineering Units
Input 3 Ratio	110	18	-20.00 to 20.00
Input 3 Bias	111	18	-999 to 9999 Engineering Units
Input 3 Filter	112	18	0 to 120 seconds

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Configuration Parameters - UDC5000, Continued

Control and Control 2

Table 6-26 lists all the I.D. codes and ranges or selections for the function parameters in setup group "CONTROL OR CONTROL 2." Loop 1 or 2 is selected by address in the request message.

Table 6-26 Setup Groups: Control and Control 2

Parameter Description	Identifying Code	Format Code	Range or Selection
Tuning Parameter Selection	172	11	0 = One set only 1 = 2 sets keyboard selected 2 = 2 sets with PV automatic switchover 3 = 2 sets with Setpoint automatic switchover
Automatic Switchover Value (used with 172 selection 2 or 3)	056	18	Within the PV Range in engineering units
Local Setpoint Source	173	11	0 = One Local Setpoint 1 = Two Local Setpoints 3 = Three Local Setpoints
Local Setpoint Tracking/Power-up Output	138	11	Setpoint Tracking / Power-up Output 0 = No Recall 1 = Yes Recall 2 = No Failsafe 3 = Yes Failsafe
PV Tracking, Control Mode and Setpoint Recall	130	11	See table below

PV Tracking	Control Model	Setpoint Mode
0 = No	Manual	Local SP
1 = Yes	Manual	Local SP
2 = No	Last*	Last*
3 = Yes	Last*	Last*
4 = No	Last*	Last*
5 = Yes	Last*	Last*

*Last before power outage

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Configuration Parameters - UDC5000, Continued

Control and Control 2, continued

Table 6-26 Setup Groups: Control and Control 2, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Control Setpoint High Limit	007	18	0 to 100% of PV (Engineering Units)
Control Setpoint Low Limit	008	18	0 to 100% of PV (Engineering Units)
Control Output Direction/Alarm Outputs	135	11	0 = Direct Action Alarm Output energized 1 = Direct Action Alarm Output de-energized 2 = Reverse Action Alarm Output energized 3 = Reverse Action Alarm Output energized
High Output Limit	014	18	–5 to 105% of output
Low Output Limit	015	18	–5 to 105% of output
High Reset Limit	016	18	–5 to 105% of output
Low Reset Limit	017	18	–5 to 105% of output
Controller Output Dropoff	139	11	0 = No dropout 1 = Dropout using ID Code 20 value
Controller Dropoff Value	020	18	–5 to 105% of output
Output Deadband	018	18	–5 to –25.0%
Output Hysteresis (Loop 1 address only)	019	18	0 to 5.0%
Failsafe Output Level	040	18	0 to 100%
Proportional Band Units Loop 1 address only) applies to Loop 1 and 2	148	11	0 = Gain 1 = Proportional band
Reset Units (Loop 1 address only) applies to Loop 1 and 2	149	11	0 = Minutes 1 = RPM

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Configuration Parameters - UDC5000, Continued

Options

Table 6-27 lists all the I.D. codes and ranges or selections for the function parameters in setup group "OPTIONS." Loop 1 or 2 is selected by address in the request message.

Table 6-27 Setup Group: Options

Parameter Description	Identifying Code	Format Code	Range or Selection
2nd Current Output	134	11	0 = None 1 = Input 1 2 = Input 2 3 = PV – Loop 1 4 = Deviation – Loop 1 5 = Output – Loop 1 6 = Setpoint – Loop 1 7 = Input 3 8 = PV – Loop 2 9 = Deviation – Loop 2 10 = Output – Loop 2 11 = Setpoint – Loop 2
Low Scaling Factor*	049	18	Within the range of the selected variable in I.D. 134
High Scaling Factory*	050	18	Within the range of the selected variable in I.D. 134
Digital Input #1*	155	11	0 = None 1 = To Manual 2 = To Local Setpoint #1 3 = To Local Setpoint #2 4 = To Direct Action 5 = To Hold Ramp/SPP 6 = To PID Set #2 7 = PV = Input 2 8 = PV = Input 3 9 = To Run Ramp/SPP 10 = To Starting Segment (SPP)
Digital Input #2*	156	11	0 = None 1 = To Manual 2 = To Local Setpoint #1 3 = To Local Setpoint #2 4 = To Direct Action 5 = To Hold Ramp/SPP 6 = To PID Set #2 7 = PV = Input 2 8 = PV = Input 3 9 = To Run Ramp/SPP 10 = To Starting Segment (SPP)

*Loop 1 address only

Continued on next page

Configuration Parameters - UDC5000, Continued

Communications

Table 6-28 lists all the I.D. codes and ranges or selections for the function parameters in setup group "COMMUNICATIONS." Loop 1 or 2 is selected in the request message.

Table 6-28 Setup Group: Communications

Parameter Description	Identifying Code	Format Code	Range or Selection
Shed Time (Loop 1 address only)	154	11	0 = No Shed 1 = 255 sample periods
Shed Mode and Output (Loop 1 address only) Selections apply to either loop	162	11	0 = Last Mode and Last Output 1 = Manual Mode, Last Output 2 = Manual Mode, Failsafe Output 3 = Automatic Mode
Shed Setpoint Recall (Loop 1 address only) Selections apply to either loop	163	11	0 = To Last Local Setpoint used 1 = Last Setpoint prior to Shed
Communication Override Units (Loop 1 address only) applies to Loop 1 and 2	161	11	0 = Percent 1 = Engineering Units
Computer Setpoint Ratio	021	18	–20.00 to 20.00
Computer Setpoint Bias	022	18	–999 to 9999

Continued on next page

Alarms

Table 6-29 lists all the I.D. codes and ranges or selections for the function parameters in setup group "ALARMS."

Table 6-29 Setup Group: Alarms

Parameter Description	Identifying Code	Format Code	Range or Selection
Alarm 1 Setpoint 1 Value	009	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 1 Setpoint 2 Value	010	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 2 Setpoint 1 Value	011	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 2 Setpoint 2 Value	012	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 1 Setpoint 1 Type	140	11	0 = None 1 = Input 1 2 = Input 2 3 = PV – Loop 1 4 = Deviation – Loop 1 5 = Output – Loop 1 6 = Alarm on Shed 7 = SP Event ON 8 = SP Event OFF 9 = Input 3 10 = PV – Loop 2 11 = Deviation – Loop 2 12 = Output – Loop 2
Alarm 1 Setpoint 2 Type	142	11	Same as 140
Alarm 2 Setpoint 1 Type	144	11	Same as 140
Alarm 2 Setpoint 2 Type	146	11	Same as 140
Alarm 1 Setpoint 1 Event	141	11	0 = Low Alarm or begin segment 1 = High Alarm or end segment

Continued on next page

Configuration Parameters - UDC5000, Continued

Alarms, continued

Table 6-29 Setup Groups: Alarms, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Alarm 1 Setpoint 2 Event	143	11	**0** = Low Alarm or begin segment **1** = High Alarm or end segment
Alarm 2 Setpoint 1 Event	145	11	**0** = Low Alarm or begin segment **1** = High Alarm or end segment
Alarm 2 Setpoint 2 Event	147	11	**0** = Low Alarm or begin segment **1** = High Alarm or end segment
Alarm Hysteresis	041	18	0.0 to 5.0% of output or span

Continued on next page

Configuration Parameters - UDC5000, Continued

Display

Table 6-30 lists all the I.D. codes and ranges or selections for function parameters in setup group "DISPLAY." Loop 1 or 2 is selected by address in the request message.

Table 6-30 Setup Groups: Display

Parameter Description	Identifying Code	Format Code	Range or Selection
Temperature Units and Decimal Point Place	129	11	Units / Decimal Places 0 = °F 0 1 = °C 0 2 = °F 1 3 = °C 1 4 = °F 2 5 = °C 2 6 = °F 3 7 = °C 3 8 = None 0 9 = None 1 10 = None 2 11 = None 3
Power Frequency (Loop 1 address only)	166	11	0 = 60 Hertz 1 = 50 Hertz
Bar graph Configuration	191	11	0 = Output 1 = Deviation 2 = Dev/Out

Section 7 – Read, Write and Override Parameters on UDC 6000 Process Controllers

Overview

Introduction

This section contains information concerning Reading, Writing, and Overriding parameters on the UDC 6000 Process Controller. There are two types of parameters:

- Data Transfer—these parameters include reading control data, option status, and reading or changing setpoints or output.
- Configuration Data—all the configuration data is list in the order in which it appears in the controller.

Each type of parameter has the identifying codes listed with it. Follow the message exchange rules listed in "Read and Write Operations."

Continued on next page

Overview - UDC6000, Continued

What's in this section

This section contains the following topics:

Continued on next page

Overview - UDC6000, Continued

General Information

Analog Parameters

- Whenever analog parameters 001 through 114 (those that can be changed via communications) are changed, a Write cycle occurs immediately after receipt of the message.

Override Parameters

- Override analog parameters 120, 123 and 125 (PV, output, computer setpoint) are not stored in non-volatile memory and can be changed as frequently as desired with no effect on non-volatile memory retentivity, but controller must remain in slave mode.

Digital Parameters

- Whenever digital configuration parameters 128 through 250 are updated via communications, the non-volatile memory is updated as soon as the message is received.

Reading Control Data - UDC6000

Overview

You can Read the following control data from the UDC controller.

- Input 1
- Input 2
- Input 3
- Input 4
- Input 5
- PV
- Internal RV
- PV, Setpoint, Output

I.D. codes

Use the identifying codes listed in Table 7-1 to read the specific items.

A Write request for these codes will result in an Error message.

Table 7-1 Control Data Parameters

Parameter Description	Identifying Code	Format Code	Range or Selection
Input #1	118	18	In Engineering Units or Percentage
Input #2	119	18	In Engineering Units or Percentage
Input #3	117	18	In Engineering Units or Percentage
Input #4	104	18	In Engineering Units or Percentage
Input #5	105	18	In Engineering Units or Percentage
PV	120	18	In Engineering Units or Percentage
Internal RV	121	18	In Engineering Units or Percentage
PV, Setpoint, and Output*	122	18	In Engineering Units or Percentage

*This Read request will give a three variable response (see Read/Write operation).

Read Options Status - UDC6000

Read

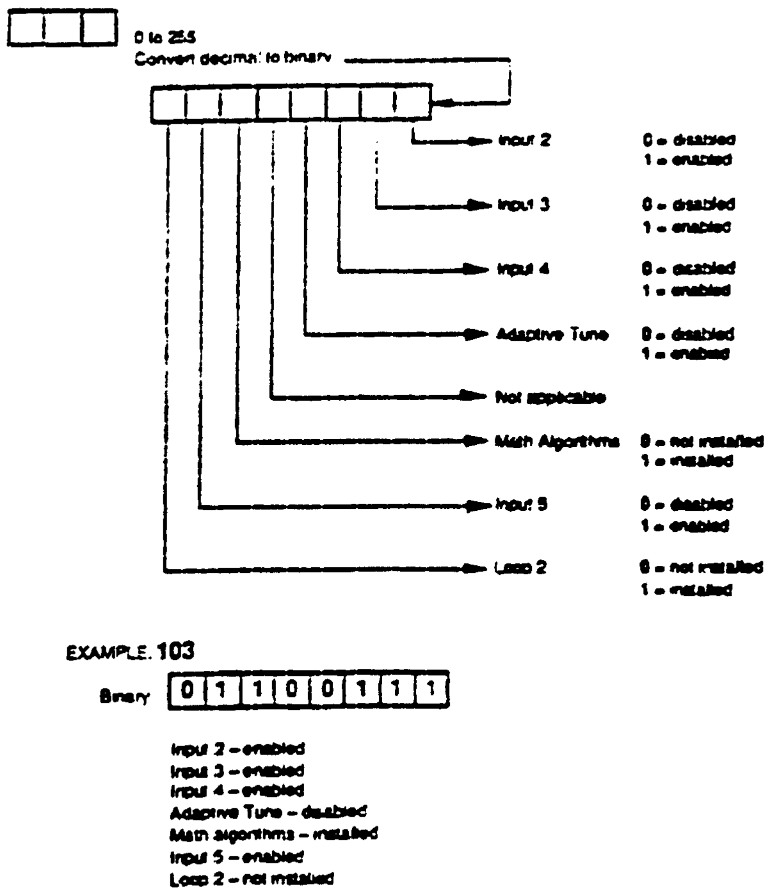
Doing a read of I.D. Code 185 listed in Table 7-2 will tell you which of the available options are enabled/installed or disabled/not installed.

Table 7-2 Option Status

Parameter Description	Identifying Code	Format Code	Range or Selection
Option Status (Read only)	185	11	See Figure 7-1

The data field in the response message will be a decimal number from 0 to 255. Convert the decimal number to binary as shown in Figure 7-1 to determine which options are or are not active.

Figure 7-1 Option Status Information



Miscellaneous Read Only's - UDC6000

I.D. codes for Read Only's

The identifying codes listed in Table 7-3 represent some information that are Read only. No Writes allowed.

Table 7-3 Miscellaneous Read Only's

Parameter Description	Identifying Code	Format Code	Range or Selection
Software Type	157	11	READ only (UDC 6000) 71 = Basic UDC 6000 software 72 = Field upgrade for Adaptive Tune 73 = Field upgrade for Adaptive Tune - Math 74 = Field upgrade for Adaptive Tune - 2 Loop 75 = Field Upgrade for all options
Software Version	167	11	READ only 0 to 99
Digital Input Switch Status (Read only)	190	11	0 = Switch #1 open Switch #2 open 1 = Switch #1 closed Switch #2 open 2 = Switch #1 open Switch #2 closed 3 = Switch #1 closed Switch #2 closed
UDC Error Status (Definitions are listed in Table 7-4)	255	11	See below READ/WRITE* 001 = Emergency Manual 002 = Failsafe 004 = Working Calibration Checksum Error 008 = Configuration Checksum Error 016 = Factory Calibration Error 032 = Hardware Failure 064 = Restart after Shed 128 = Configuration/Calibration Memory Changed

* [illegible] to clear.

For example:

If Read returns 192 (restart after shed-64 plus configuration change-128)

Write anything to I.D. Code 255

Read returns 000 (clear).

Continued on next page

Error status definitions

Table 7-4 list the UDC error status codes and their definitions.

Table 7-4 Error Status Definitions

Status Code	Error	Definitions
001	Emergency Manual	Indicates that the output of the unit which has been in slave operations, is under manual control, locally. Error remains until local control is relinquished at the controller.
002	Failsafe	Error occurs whenever the control reverts to failsafe operation and remains as long as the condition exists.
004	Working Calibration Checksum Error	Indicates that an error exists in the working calibration data. Re-select the inputs to load factory calibration data or field calibrate the inputs.
008	Configuration Checksum Error	Error exists in the configuration data. Verify configuration data at the keyboard. Checksum will be recomputed by stepping the controller through the status tests.
016	Factory Calibration Error	Error exists in the factory calibration data and remains as long as the conditions exists.
032	Hardware Failure	Indicates either a RAM tests failure or Input 1, Input 2, Input 3 failure on two consecutive conversions.
064	Restart After Shed	Error occurs whenever a shed of slave override is performed. Error is reset following a WRITE command to I.D. Code 255 (064).
128	Configuration /Calibration Memory Changed	Error occurs whenever shed, configuration, or calibration changed. Also occurs whenever there is a change of state in 001, 002, 004, 008, or 016. Error is reset following a Write command to I.D. Code 255.

Setpoints - UDC6000

Overview

You can use three separate local setpoints in the UDC Controller. The identifying codes listed Table 7-5 allow you to select which setpoint you want to use and to enter a value in Engineering Units or Percent (whichever is selected at Code 161) for that setpoint via communications.

I.D. Codes

Make your selection using I.D. Code 173 and enter the value for the setpoint chosen using ID Code 39 (SP1) or 53 (SP2) or 113 (SP3).

Table 7-5 Setpoint Code Selections

Parameter Description	Identifying Code	Format Code	Range or Selection
Local Setpoint #1	039	18	Value within the setpoint range limits
Local Setpoint #2	053	18	Value within the setpoint range limits
Local Setpoint #3	113	18	Value within the setpoint range limits
Local Setpoint Select	173	11	000 = Local Set Point #1 only 001 = 2nd Local Setpoint via keyboard or communications 003 = 3rd Local Setpoint via keyboard or communications

Associated parameters

Refer to Table 7-6 to display or change any of the parameters associated with the setpoint.

Table 7-6 Setpoint Associated Parameters

Parameter	Code
Setpoint Limits	007, 008
Computer Setpoint	125

Using a Computer Setpoint (Overriding Controller Setpoint) - UDC6000

Overview

You can use a setpoint generated from the computer to override the setpoint being used by the controller.

The value generated by the computer will have ratio and bias applied by the controller.

I.D. Codes

Use the Identifying Code in Table 7-7 to enter the computer setpoint.

Table 7-7 Computer Setpoint Selection

Parameter Description	Identifying Code	Format Code	Range or Selection
Computer Setpoint	125	18	Value from computer with Ratio/Bias applied by the controller. Within the Setpoint Range Limits in Engineering Units or Percent

Shed

The computer setpoint override will continue until "SHED" from communications occurs or the controller is placed into monitor mode through communications. Doing periodic "SLAVE READS" within the shed time will allow the override to continue until communication is stopped and shed time elapses.

ATTENTION 0 Shed (code 154) allows the override to continue indefinitely or until the override is cancelled. (See override selection ID Code 183.)

When SP is overridden, the left most digit in the upper display becomes a "C."

Continued on next page

Using a Computer Setpoint (Overriding Controller Setpoint), - UDC6000

Continued

Associated Parameters Refer to Table 7-8 for the codes to display or change any of the parameters associated with the computer setpoint.

Table 7-8 Computer Setpoint Associated Parameters

Parameter	Code
Setpoint Limits	007, 008
Local Setpoint #1	039
Local Setpoint #2	053
Local Setpoint #3	113
Local Setpoint Selection	173
Loop #1 Computer Setpoint Ratio	021
Loop #1 Computer Setpoint Bias	022

PV or Setpoint Override Selections - UDC6000

Overview

You can Read the present override status or the PV or setpoint or you can do a write transaction to cancel the override.

I.D. Codes

Use the Identifying Code in Table 7-9 to Read or Write your selection.

Table 7-9 PV or Setpoint Override Selections

Parameter Description	Identifying Code	Format Code	Range or Selection
PV or Setpoint Override Selection	183	11	04 = PV 08 = Setpoint

Reading or Changing the Output - UDC6000

Overview

You can read the output of a particular UDC controller (Read trans...) or you can change it to suit your needs. (Do a Write transaction.)

I.D. Codes

Use the identifying code in Table 7-10 to monitor (Read) or change (Write) the output (in manual only).

ATTENTION To Write (change) the output, the controller must first be in in manual mode.

Table 7-10 Reading or Changing the Output

Parameter Description	Identifying Code	Format Code	Range or Selection
Output	123	18	-5 to +105% of full span (curr output) 0 to 100% (relay type output)

Associated Parameters

Refer to Table 7-11 for the codes required to display or change any of the parameters associated with the output.

Table 7-11 Associated Output Codes

Parameter	Code
Output Limits	014, 015
Output Dropoff Limits	020
Failsafe Output Values	040
Output Deadband	018
Output Hysteresis	019
Output Type	160

Local Setpoint/PID Selection /Setpoint Ramp Status - UDC6000

Overview

Identifying Code 250 lets you

- Monitor your Setpoint Ramp Status
  - In Progress, Not in Progress
  - In Run, On Hold

  and determine which tuning set and local setpoint is being used
- Abort, Run, Hold, or Start and SP Ramp.
- Select Local Setpoint #1, #2, or #3.
- Select Tuning Parameter Set #1 or #2.

Read

When you do a Read, the code in Table 7-12 determines which parameters are active:

- Local Setpoint Selection
- Tuning Parameter Set Selection
- Setpoint Ramp Status

Table 7-12 I.D. Code 250 Reads

Parameter Description	Identifying Code	Format Code	Range or Selection
Read Local Set Point PID Set Selection and SP Ramp Status	250	11	See Figure 7-2

Continued on next page

Read, continued

Figure 7-2 I.D. Code 250 Indications

Tuning Set #2 Selection
Local Set Point #3 Selection

Tuning Set #1 Selection
Local Set Point #3 Selection

Tuning Set #2 Selection
Local Set Point #2 Selection

Tuning Set #2 Selection
Local Set Point #1 Selection

Tuning Set #1 Selection
Local Set Point #2 Selection

Tuning Set #1 Selection
Local Set Point #1 Selection

SET POINT RAMP INFORMATION (Note 1)						
SP Ramp, Enabled not in progress	000	008	016	024	032	048
SP Ramp in progress, Hold	002	010	018	026	034	050
SP Ramp in progress, Run	003	011	019	027	035	051

NOTE 1: This data is ignored in a Write command. Run/Hold set by Communications or by the Run/Hold key.

Continued on next page

Local Setpoint/PID Selection /Setpoint Ramp Status - UDC6000,

Continued

Write

A write of code 250 lets you change the SP ramp status as well as the local setpoint or tuning set selection. Refer to Table 7-13.

Table 7-13 I.D. Code 250 Writes

Parameter Description	Identifying Code	Format Code	Range or Selection
Write Local Setpoint/PID Set Selection and SP Ramp Status	250	11	000 = Abort SP Ramp 001 = Run SP Ramp 002 = Hold SP Ramp 003 = Start SP Ramp 004 = Change to Local Setpoint #1 005 = Change to Local Setpoint #2 006 = Change to PID Tuning Set #1 007 = Change to PID Tuning Set #2 008 = Change to Local Setpoint #3

ATTENTION

To enable or disable the setpoint ramp, refer to Identifying Code 150

Configuration Parameters - UDC6000

Overview

Listed on the next pages are the identifying codes for the parameters in the various Setup Groups in the UDC 6000 Process Controller. The table below lists the Setup Groups and their table numbers in which they are listed. Most of the parameters are configurable through the hosts. Some are Read Only and are indicated as such and cannot be changed.

Setup Group	Table Number
TUNING	7-14
TUNING L2	7-15
SP RAMP	7-16
ADAPTIVE	7-17
ALGORITHM	7-18
ADVANCED MATH	7-19
OUTPUT ALGORITHM	7-20
INPUT 1	7-21
INPUT 2	7-22
INPUT 3	7-23
INPUT 4	7-24
INPUT 5	7-25
CONTROL AND CONTROL 2	7-26
OPTIONS	7-27
COMMUNICATIONS	7-28
ALARMS	7-29
DISPLAY	7-30

Reading or writing

Do a Read or Write (see "Read/Write Operations"), depending on your requirements using the identifying code and format code listed in the tables. The range or selection available for each range is listed in the tables.

Continued on next page

Tuning

Table 7-14 lists all the I.D. codes and ranges or selections for the function parameters in the Setup Group "TUNING" (Loop 1).

Table 7-14 Setup Group: Tuning (Loop 1)*

Parameter Description	Identifying Code	Format Code	Range or Selection
Gain #1 or PB	001	18	0.01 to 1000
Rate #1	002	18	0.00 to 10.00
Reset #1	003	18	0.02 to 50.00
Manual Reset	013	18	-100 to +100
Gain #2 or PB	004	18	0.01 to 1000
Rate #2	005	18	0.00 to 10.00
Reset #2	006	18	0.02 to 50.00
Cycle Time #1	158	11	1 to 120 seconds
Cycle Time #2	159	11	1 to 120 seconds
Lockout (keyboard only) Changes to data always possible via communications regardless of this configuration	132	11	0 = None 1 = Calibration + Configuration 2 = Max Lockout 3 = Calibration only 4 = Calibration + Configuration + View
PV1 Value gain scheduling	001**	48	–9999 to 9999
PV2 Value gain scheduling	002**	48	–9999 to 9999
PV3 Value gain scheduling	003**	48	–9999 to 9999
PV4 Value gain scheduling	004**	48	–9999 to 9999
PV5 Value gain scheduling	005**	48	–9999 to 9999
PV6 Value gain scheduling	006**	48	–9999 to 9999
PV7 Value gain scheduling	007**	48	–9999 to 9999

Continued on next page

Configuration Parameters - UDC6000, Continued

Tuning, continued

Table 7-14 Setup Group: Tuning (Loop 1)*, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
PV8 Value gain scheduling	008**	48	−9999 to 9999
Gain 1 value gain scheduling	009**	48	0.1 to 999.9
Gain 2 value gain scheduling	010**	48	0.1 to 999.9
Gain 3 value gain scheduling	011**	48	0.1 to 999.9
Gain 4 value gain scheduling	012**	48	0.1 to 999.9
Gain 5 value gain scheduling	013**	48	0.1 to 999.9
Gain 6 value gain scheduling	014**	48	0.1 to 999.9
Gain 7 value gain scheduling	015**	48	0.1 to 999.9
Gain 8 value gain scheduling	016**	48	0.1 to 999.9

* Loop selected by address in request message.
**Extended Codes—Use Format Code 48.

Continued on next page

Tuning 2

Table 7-15 lists all the I.D. codes and ranges or selections for the function parameters in the Setup Group "TUNING 2."

Table 7-15 Setup Group: Tuning 2* (Loop 2)

Parameter Description	Identifying Code	Format Code	Range or Selection
Gain #3 or PB	001	18	0.1 to 1000
Rate #3	002	18	0.00 to 10.00
Reset #3	003	18	0.02 to 50.00
Man 3 Reset	013	18	−100 to +100
Gain #4 or PB	004	18	0.1 to 1000
Rate #4	005	18	0.00 to 10.00
Reset #4	006	18	0.02 to 50.00
Cycle Time #3	158	11	1 to 120 seconds
Cycle Time #4	159	11	1 to 120 seconds
PV1 Value gain scheduling	001**	48	−9999 to 9999
PV2 Value gain scheduling	002**	48	−9999 to 9999
PV3 Value gain scheduling	003**	48	−9999 to 9999
PV4 Value gain scheduling	004**	48	−9999 to 9999
PV5 Value gain scheduling	005**	48	−9999 to 9999
PV6 Value gain scheduling	006**	48	−9999 to 9999
PV7 Value gain scheduling	007**	48	−9999 to 9999
PV8 Value gain scheduling	008**	48	−9999 to 9999
Gain 1 value gain scheduling	009**	48	0.1 to 999.9

**Extended Codes—Use Format Code 48.

Continued on next page

Tuning 2, continued

Table 7-15 Setup Group: Tuning 2* (Loop 2), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Gain 2 value gain scheduling	010**	48	0.1 to 999.9
Gain 3 value gain scheduling	011**	48	0.1 to 999.9
Gain 4 value gain scheduling	012**	48	0.1 to 999.9
Gain 5 value gain scheduling	013**	48	0.1 to 999.9
Gain 6 value gain scheduling	014**	48	0.1 to 999.9
Gain 7 value gain scheduling	015**	48	0.1 to 999.9
Gain 8 value gain scheduling	016**	48	0.1 to 999.9

* Loop selected by address in request message.
**Extended Codes—Use Format Code 48.

Continued on next page

SP ramp/rate

Table 7-16 lists all the I.D. codes and ranges or selections for the function parameters in setup group "SP RAMP/RATE." Loop 1 or 2 selected by address in request message.

Table 7-16 Setup Group: Setpoint Ramp/Rate

Parameter Description	Identifying Code	Format Code	Range or Selection
Setpoint Ramp Enable NOTE: Cannot be enabled if **Setpoint Rate** is enabled	150	11	0 = OFF 2 = SP Ramp enabled – Loop 1 3 = SP Ramp enabled – Loop 2 4 = SP Ramp enabled – both loops
Single SP Ramp Time	174	11	0 to 255 (minutes) applies to whichever loop has SP Ramp configured
Final Ramp SP Value	025	18	PV Range in engineering units
Setpoint Rate Enable NOTE: Cannot be enabled if **Setpoint Ramp** is enabled	180	11	0 = OFF 1 = SP Rate enabled – Loop 1 2 = SP Rate enabled – Loop 2 3 = SP Rate enabled – both loops
SP Rate Up Value	057	18	0 to 9999
SP Rate Down Value	058	18	0 to 9999

Continued on next page

Configuration Parameters - UDC6000, Continued

Adaptive Tune

Table 7-17 lists all the I.D. codes and ranges or selections for the function parameters setup group "ADAPTIVE TUNE." Loop 1 or 2 is selected by address in request message.

Table 7-17 Setup Group: Adaptive Tune

Parameter Description	Identifying Code	Format Code	Range or Selection
Adaptive Tune Enable – Loop 1	152	11	**0** = Disabled **7** = SP Tune **8** = SP + PV Tune
Setpoint Change	153	11	5 to 15% span
Process Gain	114	18	0.01 to 50.0
Adaptive Tune Error (Read only)	151	11	**0** = None **1** = Output less than or greater than Output Limits **2** = Output greater or less than Heat/Cool Limits **3** = Not applicable **4** = PV change not sufficient **5** = Process Identification failed **6** = Calculated Reset outside Reset Limits **7** = Calculated Gain outside Gain Limits **8** = Adaptive tune aborted on command **9** = Input 1 error detected **10** = Adaptive Tune illegal during Ramp **11** = Adaptive Tune aborted when external switch detected.

Continued on next page

Algorithm

Table 7-18 lists all the I.D. codes and ranges or selections for the Function Parameters in setup group "ALGORITHM." Loop 1 or 2 is selected is the request message.

Table 7-18 Setup Group: Algorithm

Parameter Description	Identifying Code	Format Code	Range or Selection
Loop Rate (conversion/ second; (on Loop 1 address only)	192	11	Loop 1 Loop 2 0 = 12x disabled 1 = 9x disabled 2 = 6x 3x 3 = 3x 3x
Control Algorithm Selection †not available for Loop 2	128	11	0 = ON/OFF† 1 = PID-A 2 = PID-B 3 = PD-A with Manual Reset 4 = Three Position Step†
Loop 2 Selection (Loop 2 address only)	168	11	0 = Loop 1 only 1 = Loop 2 enabled 2 = Loop 1 and 2 are cascaded. Loop 2 primary – Loop 1 secondary.
Output Override Hi or Lo Select (on Loop 2 address only – Loop 1 Output in Auto)	136	11	0 = Disabled 1 = Hi Select 2 = Lo Select

Continued on next page

Configuration Parameters - UDC6000, Continued

Algorithm, continued

Table 7-18 Setup Group: Algorithm, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input Algorithm 1 †Input source selected via ID 193, 194, 195.	131	11	0 = None 3 = Weighted Average† 8 = Feed forward† 13 = √ Multiplier Divider† 14 = √ Multiplier† 15 = Multiplier Divider† 16 = Multiplier† 17 = Summer (with Ratio and Bias)† 18 = Input Hi Select (with Ratio and Bias)† 19 = Input Lo Select (with Ratio and Bias)†
Input Algorithm 2 †Input source selected via ID 164, 165, 186.	137	11	0 = None 3 = Weighted Average† 8 = Feed forward† 13 = √ Multiplier Divider† 14 = √ Multiplier† 15 = Multiplier Divider† 16 = Multiplier† 17 = Summer (with Ratio and Bias)† 18 = Input Hi Select (with Ratio and Bias)† 19 = Input Lo Select (with Ratio and Bias)†
Constant K for Math Algorithms	045	18	0 to 20.00
Calc High	054	18	−999 to +9999 in Engineering Units
Calc Low	055	18	−999 to +9999 in Engineering Units

Continued on next page

Configuration Parameters - UDC6000, Continued

Algorithm, continued

Table 7-18 Setup Group: Algorithm, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input Algorithm 1 Input A Selection (used with ID 131 math calculations)	193	11	**0** = Input 1 **1** = Input 2 **2** = Input 3 **3** = Input 4 **4** = Input 5 **5** = Other Algorithm
Input Algorithm 1 Input B Selection (used with ID 131 math calculations)	194	11	**0** = Input 1 **1** = Input 2 **2** = Input 3 **3** = Input 4 **4** = Input 5 **5** = Other Algorithm
Input Algorithm 1 Input C Selection (used with ID 131 math calculations)	195	11	**0** = None **1** = Input 1 **2** = Input 2 **3** = Input 3 **4** = Input 4 **5** = Input 5 **6** = Other Algorithm
Input Algorithm 2 Input A Selection (used with ID 137 math calculations)	164	11	**0** = Input 1 **1** = Input 2 **2** = Input 3 **3** = Input 4 **4** = Input 5 **5** = Other Algorithm
Input Algorithm 2 Input B Selection (used with ID 137 math calculations)	175	11	**0** = Input 1 **1** = Input 2 **2** = Input 3 **3** = Input 4 **4** = Input 5 **5** = Other Algorithm
Input Algorithm 2 Input C Selection (used with 137 math calculations)	188	11	**0** = None **1** = Input 1 **2** = Input 2 **3** = Input 3 **4** = Input 4 **5** = Input 5 **6** = Other Algorithm
8-segment Characterizer	178	11	**0** = Disable **1** = Input 2 **2** = Loop 1 – Output **3** = Loop 2 – Output

Continued on next page

Algorithm, continued

Table 7-18 Setup Group: Algorithm, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
X0 Input to 8-segment characterizer	059	18	0 to 99.99
X1 Input	060	18	0 to 99.99
X2 Input	061	18	0 to 99.99
X3 Input	062	18	0 to 99.99
X4 Input	063	18	0 to 99.99
X5 Input	064	18	0 to 99.99
X6 Input	065	18	0 to 99.99
X7 Input	066	18	0 to 99.99
X8 Input	067	18	0 to 99.99
Y0 Output from 8-segment Characterizer	068	18	0 to 99.99
Y1 Output	069	18	0 to 99.99
Y2 Output	070	18	0 to 99.99
Y3 Output	071	18	0 to 99.99
Y4 Output	072	18	0 to 99.99
Y5 Output	073	18	0 to 99.99
Y6 Output	074	18	0 to 99.99
Y7 Output	075	18	0 to 99.99
Y8 Output	076	18	0 to 99.99
Polynomial	181	11	0 = Disable 1 = Input 1 2 = Input 2 3 = Input 3 4 = Input 4 5 = Input 5

Continued on next page

Algorithm, continued

Table 7-18 Setup Group: Algorithm, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
C0 – Polynomial Coefficient	081	18	–99.99 to 99.99
C1 – Coefficient	082	18	–9.999 to 9.999
C2 – Coefficient	083	18	–9.999 to 9.999
C3 – Coefficient	084	18	–9.999 to 9.999
C4 – Coefficient	085	18	–9.999 to 9.999
C5 – Coefficient	086	18	–9.999 to 9.999
Totalizer	184	11	**0** = Disable **1** = Input 1 **2** = Input Algorithm 1 **3** = Input Algorithm 2
Totalizer Scale Factor (display only)	175	11	**0** = 10^0 = 1 **1** = 10^1 = 10 **2** = 10^2 = 100 **3** = 10^3 = 1,000 **4** = 10^4 = 10,000 **5** = 10^5 = 100,000 **6** = 10^6 = 1,000,000
Totalizer Reset Lock (when locked, totalizer cannot be reset from keyboard)	176	11	**0** = Unlock **1** = Lock
Current Totalizer Value	103	11	0 to $10^{14}-1$ NOTE: A value of "0" may be written to reset the totalizer. A write of any other value is not accepted.
Totalizer Integration Rate	177	11	**0** = Second **1** = Minute **2** = Hour **3** = Day **4** = Million/Day

Continued on next page

Configuration Parameters - UDC6000, Continued

Advanced math

Table 7-19 lists all the I.D. codes and ranges and selections for the function parameters in setup group "ADVANCED MATH." Loop 1 or 2 is selected request message.

Table 7-19 Setup Group: Advanced Math

Parameter Description	Identifying Code	Format Code	Range or Selection
Logic Gates	128**	41	**0** = Disable **1** = Enable
Gate 1 Type	129**	41	**0** = Not Used **1** = OR **2** = NOR **3** = AND **4** = NAND **5** = XOR **6** = XNOR **7** = BLTA **8** = BGTA
Gate 1 Input A (for gate types 1 through 6)	130**	41	**0** = Digital Input 1 **1** = Digital Input 2 **2** = Digital Output 1 **3** = Digital Output 2 **4** = Digital Output 3 **5** = Digital Output 4 **6** = Output from gate 1 **7** = Output from gate 2 **8** = Output from gate 3 **9** = Output from gate 4 **10** = Output from gate 5 **11** = Fixed on – always "1" **12** = Fixed off – always "0" **13** = Manual/Auto mode **14** = Local/Remote SP **15** = Disable/Enable Adaptive Tune **16** = Manual/Auto Mode (Loop 2 only)

**Extended Code—Use Format Code 41.

Continued on next page

Configuration Parameters - UDC6000, Continued

Advanced math, continued

Table 7-19 Setup Group: Advanced Math, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Gate 1 Input A (for gate types 1 through 6) continued	130**	41	17 = Local/Remote SP (Loop 2 only) 18 = Disable/Enable Adaptive Tune (Loop 2 only)
Gate 1 Input A (for gate type 7 or 8)	131**	41	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Loop 1 PV 6 = Loop 1 SP 7 = Constant K 8 = Loop 2 PV (Loop 2 address only) 9 = Loop 2 SP (Loop 2 address only)
Gate 1 Input A "K" Value (appears only if selection 7 – Constant K is made at ID Code 131)	017***	48	–999 0 to 9999
Gate 1 Input B (for gate types 1 through 6)	133**	41	Same as 130
Gate 1 Input B (for gate type 7 or 8	133**	41	0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Loop 1 PV 6 = Loop 1 SP 7 = Totalizer 8 = Loop 2 PV (Loop 2 address only) 9 = Loop 2 SP (Loop 2 address only)

**Extended Code—Use Format Code 41.
***Extended Codes—Use Format Code 48.

Continued on next page

Configuration Parameters - UDC6000, Continued

Advanced math, continued

Table 7-19 Setup Group: Advanced Math, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Gate 1 Output	134**	41	0 = Digital Output 1 1 = Digital Output 2 2 = Digital Output 3 3 = Digital Output 4 4 = Any Gate 5 = Manual/Auto Mode 6 = Local/Remote SP 7 = Disable/Enable Adaptive 8 = Manual/Auto Mode (Loop 2 address only) 9 = Local/Remote SP (Loop 2 address only) 10 = Disable/Enable Adaptive Tune (Loop 2 address only)
Gate 2 Type	135**	41	Same as 129
Gate 2 Input A (for gate types 1 through 6)	136**	41	Same as 130
Gate 2 Input A (for gate type 7 or 8)	137**	41	Same as 131
Gate 2 Input A "K" Value (appears only if selection 7 – Constant K is made at ID code 137)	018***	48	-999.0 to 9999
Gate 2 Input B (for gate types 1 through 6)	138**	41	Same as 130
Gate 2 Input B (for gate type 7 or 8)	138**	41	Same as 133
Gate 2 Output	140**	41	Same as 134
Gate 3 Type	141**	41	Same as 129

**Extended Code—Use Format Code 41.
***Extended Codes—Use Format Code 48.

Continued on next page

Advanced math, continued

Table 7-19 Setup Group: Advanced Math, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Gate 3 Input A (for gate types 1 through 6)	142**	41	Same as 130
Gate 3 Input A (for gate type 7 or 8)	143**	41	Same as 131
Gate 3 Input A "K" Value (appears only if selection 7 – Constant K is made at ID code 143)	019***	48	–999.0 to 9999
Gate 3 Input B (for gate types 1 through 6)	144**	41	Same as 130
Gate 3 Input B (for gate type 7 or 8)	145**	41	Same as 133
Gate 3 Output	146**	41	Same as 134
Gate 4 Type	147**	41	Same as 129
Gate 4 Type A (for gate types 1 through 6)	148**	41	Same as 130
Gate 4 Input A (for gate type 7 or 8)	149**	41	Same as 131
Gate 4 Input A "K" Value (appears only if selection 7 – Constant K is made at ID code 149)	020***	48	–999.0 to 9999
Gate 4 Input B (for gate types 1 through 6)	150**	41	Same as 130
Gate 4 Input B (for gate type 7 or 8)	151**	41	Same as 133
Gate 4 Output	152**	41	Same as 134
Gate 5 Type	153**	41	Same as 129

**Extended Code—Use Format Code 41.
***Extended Codes—Use Format Code 48.

Continued on next page

Configuration Parameters - UDC6000, Continued

Advanced math, continued

Table 7-19 Setup Group: Advanced Math, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Gate 5 Input A (for gate types 1 through 6)	154**	41	Same as 130
Gate 5 Input A (for gate type 7 or 8)	155**	41	Same as 131
Gate 5 Input A "K" Value (appears only if selection 7 – Constant K is made at ID code 151)	021***	48	–999.0 to 9999
Gate 5 Input B (for gate types 1 through 6)	156**	41	Same as 130
Gate 5 Input B (for gate type 7 or 8)	157**	41	Same as 133
Gate 5 Output	158**	41	Same as 134

**Extended Code—Use Format Code 41.
***Extended Codes—Use Format Code 48.

Continued on next page

Output Algorithm

Table 7-20 lists all the I.D. codes and ranges or selections for the function parameters in setup group "OUTPUT ALGORITHM." Loop 1 or 2 is selected in the request message.

Table 7-20 Setup Group: Output Algorithm

Parameter Description	Identifying Code	Format Code	Range or Selection
Output Algorithm	160	11	0 = None (Loop 1) – Disabled (Loop 2) 2 = Time Simplex 3 = Time Duplex (Loop 1 only) 4 = Current 5 = Current Duplex 6 = Time/Current 7 = Current/Time
Digital Output State at 0% Output (on Loop 1 address only)	136	11	0 = Out 3 de-energized Out 4 de-energized 1 = Out 3 energized Out 4 de-energized 2 = Out 3 de-energized Out 4 energized 3 = Out 3 energized Out 4 energized

Continued on next page

Input 1

Table 7-21 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 1."

Table 7-21 Setup Group: Input 1 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 1 Type	168	11	0 = OFF 27 = Linear NOTE. If 0 is received as a write, the input is disabled and the transmitter selection is lost. Whenever 27 is received as a write, if the input was previous disabled, the transmitter selection is set to linear with a range indeterminate; however, if the input was previously enabled, the transmitter type is unchanged.
Input 1 Transmitter Characterization	169	11	0 = B T/C 1 = E T/C 2 = J T/C 3 = K T/C 4 = NiNiMo T/C 5 = R T/C 6 = S T/C 7 = T T/C 8 = W T/C 11 = Nicrosil-Nisil T/C 12 = 100 Pt RTD 19 = Linear 20 = Sq. Root 27 = 100 Pt RTD Low 28 = 200 Pt RTD 29 = 500 Pt RTD
Input 1 High Range Value	029	18	–999. to 9999. Engineering Units
Input 1 Low Range Value	030	18	–999 to 9999. Engineering Units
Input 1 Ratio	106	18	–20.00 to 20.00
Input 1 Bias	107	18	–999 to 9999. Engineering Units
Input 1 Filter	042	18	0 to 120 seconds

Continued on next page

Input 2

Table 7-22 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 2."

Table 7-22 Setup Group: Input 2 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 2 Type	170	11	0 = OFF 27 = Linear NOTE: If 0 is received as a write, the input is disabled and the transmitter selection is lost. Whenever 27 is received as a write, if the input was previous disabled, the transmitter selection is set to linear with a range indeterminate; however, if the input was previously enabled, the transmitter type is unchanged.
Input 2 Transmitter Characterization	171	11	0 = B T/C 1 = E T/C 2 = J T/C 3 = K T/C 4 = NiNiMo T/C 5 = R T/C 6 = S T/C 7 = T T/C 8 = W T/C 11 = Nicrosil-Nisil T/C 12 = 100 Pt RTD 19 = Linear 20 = Sq. Root 27 = 100 Pt RTD Low 28 = 200 Pt RTD 29 = 500 Pt RTD
Input 2 High Range Value	035	18	–999. to 9999. Engineering Units
Input 2 Low Range Value	036	18	–999 to 9999. Engineering Units
Input 2 Ratio	037	18	–20.00 to 20.00
Input 2 Bias	038	18	–999 to 9999. Engineering Units
Input 2 Filter	043	18	0 to 120 seconds

Continued on next page

Input 3

Table 7-23 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 3."

Table 7-23 Setup Group: Input 3 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 3 Type	185	11	0 = OFF 27 = Linear NOTE: If 0 is received as a write, the input is disabled and the transmitter selection is lost. Whenever 27 is received as a write, if the input was previous disabled, the transmitter selection is set to linear with a range indeterminate: however, if the input was previously enabled, the transmitter type is unchanged.
Input 3 Transmitter Characterization	187	11	0 = B T/C 1 = E T/C 2 = J T/C 3 = K T/C 4 = NiNiMo T/C 5 = R T/C 6 = S T/C 7 = T T/C 8 = W T/C 11 = Nicrosil-Nisil T/C 12 = 100 Pt RTD 19 = Linear 20 = Sq. Root 27 = 100 Pt RTD Low 28 = 200 Pt RTD 29 = 500 Pt RTD
Input 3 High Range Value	108	18	–999. to 9999. engineering units
Input 3 Low Range Value	109	18	–999 to 9999. engineering units
Input 3 Ratio	110	18	–20.00 to 20.00
Input 3 Bias	111	18	–999 to 9999. engineering units
Input 3 Filter	112	18	0 to 120 seconds

Continued on next page

Input 4

Table 7-24 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 4."

Table 7-24 Setup Group: Input 4 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 4 Type	202	11	0 = OFF 27 = Linear NOTE: If 0 is received as a write, the input is disabled and the transmitter selection is lost. Whenever 27 is received as a write, if the input was previous disabled, the transmitter selection is set to linear with a range indeterminate; however, if the input was previously enabled, the transmitter type is unchanged.
Input 4 Transmitter Characterization	203	11	0 = B T/C 1 = E T/C 2 = J T/C 3 = K T/C 4 = NiNiMo T/C 5 = R T/C 6 = S T/C 7 = T T/C 8 = W T/C 11 = Nicrosil-Nisil T/C 12 = 100 Pt RTD 19 = Linear 20 = Sq. Root 27 = 100 Pt RTD Low 28 = 200 Pt RTD 29 = 500 Pt RTD
Input 4 High Range Value	087	18	–999. to 9999. engineering units
Input 4 Low Range Value	088	18	–999 to 9999. engineering units
Input 4 Ratio	089	18	–20.00 to 20.00
Input 4 Bias	090	18	–999 to 9999. engineering units
Input 4 Filter	091	18	0 to 120 seconds

Continued on next page

Input 5

Table 7-25 lists all the I.D. codes and ranges or selections for the function parameters in setup group "INPUT 5."

Table 7-25 Setup Group: Input 5 (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 5 Type	204	11	0 = OFF 1 = E T/C 2 = J T/C 3 = K T/C 4 = NiNiMo T/C 5 = R T/C 6 = S T/C 7 = T T/C 8 = W T/C 9 = B T/C 11 = Nicrosil Nisil T/C 12 = 100 Pt RTD 14 = 200 Pt RTD 15 = 500 Pt RTD 19 = Radiamatic 22 = 4-20 mA 23 = 0-10 mV 24 = 10-50 mV 25 = 1 to 5 volts 26 = 0 to 10 volts 36 = 100 Pt RTD Low 37 = Pulse (only when pulse input board is installed)
Input 5 Type (when pulse input is installed – i.e. 37 above)	207	11	0 = Disabled 1 = Frequency Input 2 = Pulse Input

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Configuration Parameters - UDC6000, Continued

Input 5, continued

Table 7-25 Setup Group: Input 5 (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Input 5 Transmitter Characterization	205	11	0 = B T/C 1 = E T/C 2 = J T/C 3 = K T/C 4 = NiNiMo T/C 5 = R T/C 6 = S T/C 7 = T T/C 8 = W T/C 11 = Nicrosil-Nisil T/C 12 = 100 Pt RTD 19 = Linear 20 = Sq. Root 27 = 100 Pt RTD Low 28 = 200 Pt RTD 29 = 500 Pt RTD
Input 5 High Range Value	092	18	–999. to 9999. engineering units
Input 5 Low Range Value	093	18	–999 to 9999. engineering units
Input 5 Ratio	094	18	–20.00 to 20.00
Input 5 Bias	095	18	–999 to 9999. engineering units
Input 5 Filter	096	18	0 to 120 seconds
Input 5 Burnout	206	11	0 = None 1 = Upscale 2 = Downscale
Input 5 Emissivity	097	18	0.01 to 1.00

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Control and Control 2

Table 7-26 lists all the I.D. codes and ranges or selections for the function prompts in setup group "CONTROL OR CONTROL 2." Loop 1 or 2 address selected in request message.

Table 7-26 Setup Group: Control and Control 2

Parameter Description	Identifying Code	Format Code	Range or Selection
PV Source	196	11	**0** = Input 1 **1** = Input 2 **2** = Input 3 **3** = Input 4 **4** = Input 5 **5** = Input Algorithm 1 **6** = Input Algorithm 2
Tuning Parameter Selection	172	11	**0** = One set only **1** = 2 sets keyboard selected **2** = 2 sets with PV automatic switchover **3** = 2 sets with setpoint automatic switchover **4** = Gain scheduling
Automatic Switchover Value (used with 172 selection 2 or 3)	056	18	Within the PV Range in engineering units
Local Setpoint Source	173	11	**0** = One Local Setpoint **1** = Two Local Setpoints **3** = Three Local Setpoints

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Configuration Parameters - UDC6000, Continued

Control and Control 2, continued

Table 7-26 Setup Group: Control and Control 2, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Setpoint Source	197	11	**0** = Local Setpoint only **1** = Remote Setpoint via Input 2 **2** = Remote Setpoint via Input 3 **3** = Remote Setpoint via Input 4 **4** = Remote Setpoint via Input 5 **5** = RSP using Input Algorithm 1 **6** = RSP using Input Algorithm 2
Auto-Bias (LSP to RSP)	196	11	**0** = Disabled (bump) **1** = Enabled (bumpless)
Setpoint Tracking	138	11	**0** = NO **1** = YES
Control Setpoint High Limit	007	18	0 to 100% of PV (engineering units)
Control Setpoint Low Limit	008	18	0 to 100% of PV (engineering units)
Control Output Direction/Alarm Outputs	135	11	**0** = Direct Action Alarm Output energized **1** = Direct Action Alarm Output de-energized **2** = Reverse Action Alarm Output energized **3** = Reverse Action Alarm Output de-energized
High Output Limit	014	18	–5 to 105% of output
Low Output Limit	015	18	–5 to 105% of output
High Reset Limit	016	18	–5 to 105% of output

Continued on next page

Configuration Parameters - UDC6000, Continued

Control and Control 2, continued

Table 7-26 Setup Group: Control and Control 2, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Low Reset Limit	017	18	–5 to 105% of output
Output Rate	182	11	0 = Disable 1 = Enable
Output Rate Value Up	044	18	0 to 9999%/minute
Output Rate Value Down	046	18	0 to 9999%/minute
Controller Dropoff Value	020	18	–5 to 105% of output
Output Deadband	018	18	–5 to +25.0%
Output Hysteresis (Loop 1 address only)	019	18	0 to 5.0%
Failsafe Mode	199	11	0 = Latching 1 = Non latching
Failsafe Output Level	040	18	0 to 100%
Proportional Band Units (Loop 1 address only) applies to Loop 1 and 2	148	11	0 = Gain 1 = Proportional band
Reset Units (Loop 1 address only) applies to Loop 1 and 2	149	11	0 = Minutes 1 = RPM

Continued on next page

Configuration Parameters - UDC6000, Continued

Options

Table 7-27 lists all the I.D. codes and ranges or selections for the function parameters in setup group "OPTIONS." Loop 1 or 2 is selected in the request message.

Table 7-27 Setup Groups: Options

Parameter Description	Identifying Code	Format Code	Range or Selection
2nd Current Output	134	11	**0** = None **1** = Input 1 **2** = Input 2 **3** = PV – Loop 1 **4** = Deviation – Loop 1 **5** = Output – Loop 1 **6** = Setpoint – Loop 1 **7** = Input 3 **8** = PV – Loop 2 **9** = Deviation – Loop 2 **10** = Output – Loop 2 **11** = Setpoint – Loop 2 **12** = Input 4 **13** = Input 5
Low Scaling Factor (Loop 1 address only)	049	18	Within the range of the selected variable in I.D 134
High Scaling Factory (Loop 1 address only)	050	18	Within the range of the selected variable in I.D. 134

Continued on next page

Configuration Parameters - UDC6000, Continued

Options, continued

Table 7-27 Setup Groups: Options, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Digital Input #1 (Loop 1 address only)	155	11	0 = None 1 = To Manual 2 = To Local Setpoint #1 3 = To Local Setpoint #2 4 = To Direct Action 5 = To Hold Ramp 6 = To PID Set #2 7 = PV = Input 2 8 = PV = Input 3 9 = To Run Ramp 10 = To Local Setpoint #3 11 = PV = Input 4 12 = PV = Input 5 13 = To Manual/ Failsafe Output 14 = Output 1 tracks Input 4 15 = Output 2 tracks Input 4 16 = Output 2 overrides Output 1 17 = Pulse Down 18 = Out 3 On 19 = Out 4 On 20 = Inhibit Reset 21 = To RSP 22 = Display – Loop 2 For 0 through 255 loop selected by address in request message. For digital input combinations see Figure 7-3 below.

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Configuration Parameters - UDC6000, Continued

Options, continued

Table 7-27 Setup Groups: Options, continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Digital Input #2 (Loop 1 address only)	156	11	**0** = None **1** = To Manual **2** = To Local Setpoint #1 **3** = To Local Setpoint #2 **4** = To Direct Action **5** = To Hold Ramp **6** = To PID Set #2 **7** = PV = Input 2 **8** = PV = Input 3 **9** = To Run Ramp **10** = To Local Setpoint #3 **11** = PV = Input 4 **12** = PV = Input 5 **13** = To Manual/ Failsafe Output **14** = Output 1 tracks Input 4 **15** = Output 2 tracks Input 4 **16** = Output 2 overrides Output 1 **17** = Pulse Down **18** = Out 3 On **19** = Out 4 On **20** = Inhibit Reset **21** = To RSP **22** = Display – Loop 2 Digital Input 2 combinations are the same as Digital Input 1, Figure 7-3.

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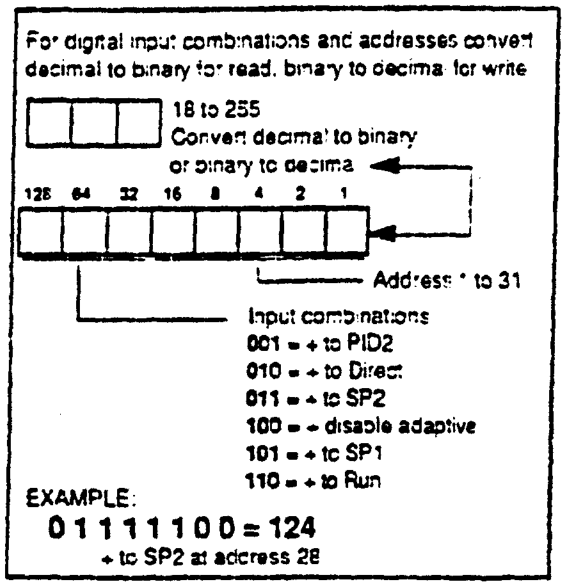
Configuration Parameters - UDC6000, Continued

Options, continued

Figure 7-3 Digital Input Combinations



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Configuration Parameters - UDC6000, Continued

Communications

Table 7-28 lists all the I.D. codes and ranges or selections for the function parameters in setup group "COM." Loop 1 or 2 is selected in the request message.

Table 7-28 Setup Group: Communications

Parameter Description	Identifying Code	Format Code	Range or Selection
Shed Time (Loop 1 address only)	154	11	0 = No Shed 1 = 255 sample periods
Shed Mode and Output (Loop 1 address only) Selections apply to either loop	162	11	0 = Last Mode and Last Output 1 = Manual Mode, Last Output 2 = Manual Mode, Failsafe Output 3 = Automatic Mode
Shed Setpoint Recall (Loop 1 address only) Selections apply to either loop	163	11	0 = To Last Local Setpoint used 1 = Last Setpoint prior to Shed
Communication Override Units (Loop 1 address only) applies to Loop 1 and 2	161	11	0 = Percent 1 = Engineering Units
Computer Setpoint Ratio	021	18	−20.00 to 20.00
Computer Setpoint Bias	022	18	−999 to 9999.

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Alarms

Tables 7-29 lists all the I.D. codes and ranges or selections for the function parameters in setup group "ALARMS."

Table 7-29 Setup Group: Alarms (Loop 1 Address only)

Parameter Description	Identifying Code	Format Code	Range or Selection
Alarm 1 Setpoint 1 Value	009	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 1 Setpoint 2 Value	010	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 2 Setpoint 1 Value	011	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 2 Setpoint 2 Value	012	18	Within the range of selected parameter or PV span for deviation alarm
Alarm 1 Setpoint 1 Type	140	11	0 = None 1 = Input 1 2 = Input 2 3 = PV – Loop 1 4 = Deviation – Loop 1 5 = Output – Loop 1 6 = Alarm on Shed 9 = Input 3 10 = PV – Loop 2 11 = Deviation – Loop 2 12 = Output – Loop 2 13 = Input 4 14 = Input 5
Alarm 1 Setpoint 2 Type	142	11	Same as 140
Alarm 2 Setpoint 1 Type	144	11	Same as 140
Alarm 2 Setpoint 2 Type	146	11	Same as 140
Alarm 1 Setpoint 1 Event	141	11	0 = Low Alarm 1 = High Alarm
Alarm 1 Setpoint 2 Event	143	11	0 = Low Alarm 1 = High Alarm
Alarm 2 Setpoint 1 Event	145	11	0 = Low Alarm 1 = High Alarm

Continued on next page

Configuration Parameters - UDC6000, Continued

Alarms, continued

Table 7-29 Setup Group: Alarms (Loop 1 Address only), continued

Parameter Description	Identifying Code	Format Code	Range or Selection
Alarm 2 Setpoint 2 Event	147	11	0 = Low Alarm 1 = High Alarm
Alarm Hysteresis	041	18	0.0 to 5.0% of output or span
Alarm Latching for Loop 1	200	11	0 = Non Latching 1 = Latching
Alarm Latching for Loop 2	201	11	0 = Non Latching 1 = Latching

Display

Table 7-30 lists all the I.D. codes and ranges or selections for the function parameters in setup group "DISPLAY." Loop 1 or 2 is selected by address in the request message.

Table 7-30 Setup Group: Display

Parameter Description	Identifying Code	Format Code	Range or Selection
Temperature Units and Decimal Point Place	129	11	Units / Decimal Places 0 = °F 0 1 = °C 0 2 = °F 1 3 = °C 1 4 = °F 2 5 = °C 2 6 = °F 3 7 = °C 3 8 = None 0 9 = None 1 10 = None 2 11 = None 3
Power Frequency (Loop 1 address only)	166	11	0 = 60 Hertz 1 = 50 Hertz

Section 8 – Operating the Controller with Communications Option

Operation

Introduction

During communications the controller can operate in various modes and the operator can assume manual control of the output. There are various indications of these actions.

Monitor mode

During "Monitor Mode" the UDC will control normally with operator access allowed at the keyboard. See the individual Product Manual.

Slave mode

During "Slave" operation:

- Configuration data may not be changed via the front keyboard.
- MAN annunciator is OFF.
- The controller will use override data provided at the computer.

Emergency manual

During "Slave" operation the operator can assume manual control of the output (Emergency Manual). The procedure in Table 8-1 tells you how to start and stop emergency manual.

Table 8-1 Emergency Manual Procedure

Operation	Action
Start Emergency Manual	• Press [MAN/AUTO]. • MAN annunciator comes ON. • Press [▲] or [▼] to position the output manually.
End Emergency Manual	• Press [MAN/AUTO] key - this second press ends the Emergency Manual operation. The controller reverts to "Slave" mode, Manual output. • MAN annunciator goes OFF.

Overriding setpoint or PV indication

When setpoint or PV are overriden, the first digit in the upper display = C.

Section 9 – ASCII Conversion Table

Overview

Overview

Table 9-1 lists all the Hex and Decimal designations for all the ASCII Character Codes.

Table 9-2 is a Hex, Decimal, and Binary conversion table.

Table 9-1 ASCII Character Codes

Control				Figures			Uppercase			Lowercase		
ASCII		HEX	DEC	ASCII	HEX	DEC	ASCII	HEX	DEC	ASCII	HEX	DEC
NUL	(CTL @)	00	0	space	20	32	@	40	64	\`	60	96
SOH	(CRL A)	01	1	!	21	33	A	41	65	a	61	97
STX	(CTL B)	02	2	"	22	34	B	42	66	b	62	98
ETX	(CTL C)	03	3	#	23	35	C	43	67	c	63	99
EOT	(CTL D)	04	4	$	24	36	D	44	68	d	64	100
ENQ	(CTL E)	05	5	%	25	37	E	45	69	e	65	101
ACK	(CTL F)	06	6	&	26	38	F	46	70	f	66	102
BEL	(CTL G)	07	7	'	27	39	G	47	71	g	67	103
BS	(CTL H)	08	8	(	28	40	H	48	72	h	68	104
HT	(CTL I)	09	9	)	29	41	I	49	73	i	69	105
LF	(CTL J)	0A	10	*	2A	42	J	4A	74	j	6A	106
VT	(CTL K)	0B	11	+	2B	43	K	4B	75	k	6B	107
FF	(CTL L)	0C	12	,	2C	44	L	4C	76	l	6C	108
CR	(CTL M)	0D	13	-	2D	45	M	4D	77	m	6D	109
SO	(CTL N)	0E	14	.	2E	46	N	4E	78	n	6E	110
SI	(CTL O)	0F	15	/	2F	47	O	4F	79	o	6F	111
DLE	(CTL P)	10	16	0	30	48	P	50	80	p	70	112
DC1	(CTL Q)	11	17	1	31	49	Q	51	81	q	71	113
DC2	(CTL R)	12	18	2	32	50	R	52	82	r	72	114
DC3	(CTL S)	13	19	3	33	51	S	53	83	s	73	115
DC4	(CTL T)	14	20	4	34	52	T	54	84	t	74	116
NAK	(CTL U)	15	21	5	35	53	U	55	85	u	75	117
SYN	(CTL V)	16	22	6	36	54	V	56	86	v	76	118
ETB	(CTL W)	17	23	7	37	55	W	57	87	w	77	119
CAN	(CTL X)	18	24	8	38	56	X	58	88	x	78	120
EM	(CTL Y)	19	25	9	39	57	Y	59	89	y	79	121
SUB	(CTL Z)	1A	26	:	3A	58	Z	5A	90	z	7A	122
ESC	(CTL [)	1B	27	;	3B	59	[	5B	91	{	7B	123
FS	(CTL \)	1C	28	<	3C	60	\	5C	92		7C	124
GS	(CTL])	1D	29	=	3D	61	]	5D	93	}	7D	125
RS	(CTL ^)	1E	30	>	3E	62	^	5E	94	~	7E	126
US	(CTL _)	1F	31	?	3F	63	_	5F	95	DEL	7F	127

Continued on next page

Overview, Continued

Overview, continued

Table 9-2 Hexadecimal to Binary

HEX	DEC	BINARY	HEX	DEC	BINARY	HEX	DEC	BINARY	HEX	DEC	BINARY
0	0	0000	4	4	0100	8	8	1000	C	12	1100
1	1	0001	5	5	0101	9	9	1001	D	13	1101
2	2	0010	6	6	0110	A	10	1010	E	14	1110
3	3	0011	7	7	0111	B	11	1011	F	15	1111

Section 10 – Cable Specifications

Introduction

Introduction Table 10-1 lists the cable specifications for 2000 feet or 5000 feet cabled used for wiring the communications link.

Table 10-1 Cable Specifications

	2000 Foot Cable	5000 Foot Cable
Cable Type	Two-conductor stranded (twin axial). 100% shield. 120 ohms. #25 AWG. polyethylene insulated. with aluminum-mylar shield, drain wire, and vinyl jacket.	Two-conductor stranded (twin axial). 100% shield. 150 ohms. #25 AWG. datalene insulated, with aluminum-mylar shield. drain wire, and vinyl or teflon jacket.
Commercial Equivalent	Belden Corporation type 9271 Twinax	Belden Corporation type 9182 Twinax OR Belden Corporation type 89128 Twinax
Electrical Characteristics		
Characteristic Impedance	124 ohms	150 ohms
Resistance: Center Conductors Shield	 104.3 ohms per kilometer 39.4 ohms per kilometer	 49.2 ohms per kilometer 15 ohms per kilometer
Capacitance	40 picofarads per meter	28.9 picofarads per meter
Attenuation	at 1 MHz – 2 db per 100 meters at 10 MHz – 5.6 db per 100 meters	at 1 MHz – .98 db per 100 meters at 10 MHz – 4.0 db per 100 meters
Mechanical Characteristics		
Center Conductor Insulation	Polyethylene	Datalene®
Jack Composition	Vinyl (PVC)	Vinyl (PVC) (Belden 9182) or Teflon (Belden 89182)
Jacket Outer Diameter	6.1 millimeters	8.9 millimeters
Environmental Limits		
Temperature	–20 to 80°C (–4 to 176°F)	–20 to 80°C (–4 to 176°F)
Relative Humidity	5 to 95%	5 to 95%
Distance Limits	625 meters (2000 feet) Cable must be terminated at each end with a 124 ohm ±10% 1/4 watt resistor.	1524 meters (5000 feet) Cable must be terminated at each end with a 150 ohm ±10% 1/4 watt resistor.
Maximum Number of Devices	15	15
Baud Rate	19.2K	19.2K

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U, V

W, X, Y, Z

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